

## Subpart M—Evaporative Emission Test Procedures for New Gasoline-Fueled, Natural Gas-Fueled, Liquefied Petroleum Gas-Fueled and Methanol-Fueled Heavy-Duty Vehicles

AUTHORITY: Secs. 202, 206, 301, Clean Air Act as amended, 42 U.S.C. 7521, 7525, 7601.

SOURCE: 48 FR 1456, Jan. 12, 1983, unless otherwise noted.

### § 86.1201-90 Applicability.

(a) The provisions of this subpart are applicable to new gasoline-fueled, natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled heavy-duty vehicles.

(b) Provisions of this subpart apply to tests performed by both the Administrator and motor vehicle manufacturers.

(c) Test procedures and equipment other than those described in this subpart may be used by the vehicle manufacturer if shown to yield results which correlate with results yielded by those described in this subpart (with the reference driving schedule described in § 86.1215-85(a)) and if approved in advance by the Administrator.

[54 FR 14562, Apr. 11, 1989, as amended at 59 FR 48521, Sept. 21, 1994]

### § 86.1202-85 Definitions.

Applicable definitions in §§ 86.077-2, 86.078-2, 86.079-2, 86.080-2, 86.081-2, 86.082-2 and 86.085-2 apply to this subpart.

### § 86.1203-85 Abbreviations.

The abbreviations in § 86.079-3 apply to this subpart.

### § 86.1204 Section numbering.

The section numbering system set forth in § 86.104 applies to this subpart.

[59 FR 48521, Sept. 21, 1994]

### § 86.1205-90 Introduction; structure of subpart.

(a) This subpart describes the equipment required and the procedures to follow in order to determine evaporative emission levels from gasoline-fueled, natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled heavy-duty vehicles.

(b) Three topics are addressed in this subpart. Sections 86.1206 through 86.1215 set forth specifications and equipment requirements; §§ 86.1216 through 86.1226 discuss calibration methods and

frequency; test procedures and data requirements are listed in §§ 86.1227 through 86.1246.

[54 FR 14562, Apr. 11, 1989, as amended at 58 FR 16047, Mar. 24, 1993; 59 FR 48521, Sept. 21, 1994]

### § 86.1206-90 Equipment required; overview.

This subpart specifies procedures for testing of gasoline-fueled and methanol-fueled heavy-duty vehicles. Equipment required and specifications are as follows:

(a) *Evaporative emissions tests.* § 86.1207 specifies the necessary equipment.

(b) *Fuel, analytical gas, and driving schedule specifications.* Fuel specifications for emission testing and for service accumulation are specified in § 86.1213. Analytical gases are specified in § 86.1214. Both vehicle preconditioning for the diurnal loss test and vehicle operation prior to the hot soak loss test include operation on a chassis dynamometer. The driving cycle (EPA heavy-duty vehicle urban dynamometer driving schedule) is specified in § 86.1215.

[54 FR 14562, Apr. 11, 1989]

### § 86.1206-96 Equipment required; overview.

This subpart specifies procedures for testing of gasoline-fueled, natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled heavy-duty vehicles. Equipment required and specifications are as follows:

(a) *Evaporative emission tests.* Section 86.1207 specifies the necessary equipment.

(b) *Fuel, analytical gas, and driving schedule specifications.* Fuel specifications for emission testing and for service accumulation are specified in § 86.1213. Analytical gases are specified in § 86.1214. Evaporative testing requires vehicle operation on a chassis dynamometer. The driving cycle (EPA Heavy-Duty Vehicle Urban Dynamometer Driving Schedule) is specified in § 86.1215.

[58 FR 16047, Mar. 24, 1993, as amended at 59 FR 48521, Sept. 21, 1994]

### § 86.1207-90 Sampling and analytical system; evaporative emissions.

The following is a description of the components which will be used in evaporative emissions sampling systems for testing under this subpart.

(a) *Evaporative emission measurement enclosure.* The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with § 86.1217. Interior surfaces must be impermeable and non-reactive to hydrocarbons and to methanol

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(if used for methanol-fueled vehicles). One surface should be of flexible, impermeable and non-reactive material to allow for minor volume changes, resulting from temperature changes. Wall design should promote maximum dissipation of heat, and if artificial cooling is used, interior surface temperatures shall not be less than 68 °F (20 °C).

(b) *Evaporative emission hydrocarbon and methanol analyzers.* (1) For gasoline and methanol-fueled vehicles a hydrocarbon analyzer utilizing the hydrogen flame ionization principle (FID) shall be used to monitor the atmosphere within the enclosure (a heated FID (HFID)(235°±15°F (113±8°C)) is recommended for methanol-fueled vehicles). Instrument bypass flow may be returned to the enclosure. The FID shall have a response time to 90 percent of final reading of less than 1.5 seconds, and be capable of meeting performance requirements expressed as a function of Cstd: where Cstd is the specific enclosure hydrocarbon level, in ppm, corresponding to the evaporative emission standard:

(i) Stability of the analyzer shall be better than 0.01 Cstd ppm at zero and span over a 15-minute period on all ranges used.

(ii) Repeatability of the analyzer, expressed as one standard deviation, shall be better than 0.005 Cstd ppm on all ranges used.

(2) For methanol-fueled vehicles, a methanol sampling and analyzing system is required in addition to the FID analyzer. The methanol sampling equipment shall consist of impingers for collecting the methanol sample and appropriate equipment for drawing the sample through the impingers. The analytical equipment shall consist of a gas chromatograph equipped with a flame ionization detector. (Note: For 1990 through 1994 model year methanol-fueled vehicles, a HFID, calibrated on methanol may be used in place of the HFID calibrated on propane plus the methanol impingers and associated analytical equipment.)

(3) The methanol sampling system described in paragraph (b)(2) of this section shall be designed such that, if a test vehicle emitted the maximum allowable level of methanol (based on all applicable standards) during any phase of the test, the measured concentration in the primary impinger would exceed either 25 mg/l or a concentration equal to 25 times the limit of detection for the GC analyzer, and such that the primary impinger collects at least 90 percent of the analyte in the samples. The remaining analyte shall be collected by the secondary impinger. The provisions of this paragraph apply to the design of sampling systems, not to individual tests.

(c) *Evaporative emission hydrocarbon and methanol data recording system.* (1) The electrical output of the FID used for measuring hydrocarbons (or hydrocarbons plus methanol as appro-

priate) shall be recorded at least at the initiation and termination of each diurnal or hot soak. The recording may be by means of a strip chart potentiometric recorder, by use of an on-line computer system or other suitable means. In any case, the recording system must have operational characteristics (signal to noise ratio, speed of response, etc.) equivalent to or better than those of the signal source being recorded, and must provide a permanent record of results. The record shall show a positive indication of the initiation and completion of each diurnal or hot soak along with the time elapsed between initiation and completion of each soak.

(2) For the methanol sample, permanent records shall be made of the following: the volumes of deionized water introduced into each impinger, the rate and time of sample collection and the chromatogram of the analyzed sample.

(d) *Tank fuel heating system.* The tank fuel heating system shall consist of a heat source and a temperature controller. A typical heat source is a 2,000 W heating pad. Other sources may be used as required by circumstances. The temperature controller may be manual, such as a variable voltage transformer, or may be automated. The heating system must not cause hot spots on the tank wetted surface which could cause local overheating of the fuel. Heat must not be applied to the vapor in the tank above the liquid fuel. The temperature controller must be capable of controlling the fuel tank temperature during the diurnal soak to within ±3 °F (±1.7 °C) of the following equation:

$$(1) F = T_o + (0.4)t$$

$$(2) \text{ For SI units, } C = T_o + (2/9)t$$

Where:

F = Temperature in °F.

C = Temperature in °C.

t = Time since start of test in minutes.

T<sub>o</sub> = Initial temperature in °F (or in °C for SI units).

(e) *Temperature recording system.* Strip chart recorder(s) or an automatic data processor shall be used to record enclosure ambient and vehicle fuel tank temperature at least once every minute. The temperature recorder or data processor shall have a time accuracy of ±15s, a time precision of ±15s and be capable of resolving temperature to ±0.75 °F (±0.42 °C). The temperature recording system (recorder and sensor) shall have an accuracy of ±3 °F (±1.7 °C). Two ambient temperature sensors, connected to provide one average output, shall be located in the enclosure. These sensors shall be located at the approximate vertical centerline of each side wall extending 4 inches (nominally) into the enclosure at a height of 3±0.5 ft (0.9±0.2 m). The vehicle fuel tank temperature sensor shall be located in the fuel tank so as to measure the temperature of the prescribed test fuel at the approxi-

mate mid-volume of the fuel. Manufacturers shall arrange that vehicles furnished for testing at Federal certification facilities be equipped with iron-constantan Type J thermocouples for measurement of fuel tank temperature.

(f) *Purge blower.* One or more portable or fixed blowers shall be used to purge the enclosure. The blowers shall have sufficient flow capacity to reduce the enclosure hydrocarbon and/or methanol concentration from the test level to the ambient level between tests. Actual flow capacity will depend upon the time available between tests.

(g) *Mixing blower.* One or more blowers or fans with a total capacity of 250 to 750 cfm per 1,000 ft<sup>3</sup> of enclosure volume shall be used to mix the contents of the enclosure during evaporative emission testing. The mixing blower(s) shall be arranged such that a uniform concentration is maintained. No portion of the air stream shall be directed towards the vehicle.

[54 FR 14562, Apr. 11, 1989, as amended at 60 FR 34358, June 30, 1995]

**§86.1207-96 Sampling and analytical systems; evaporative emissions.**

(a) *Testing enclosures—(1) Diurnal emission test.* The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with § 86.1217-96. Interior surfaces must be impermeable and nonreactive to hydrocarbons (and to methanol, if the enclosure is used for methanol-fueled vehicles). The temperature conditioning system shall be capable of controlling the internal enclosure air temperature to follow the prescribed temperature versus time cycle as specified in § 86.1233-96 and Appendix II of this part, within an instantaneous tolerance of  $\pm 3.0$  °F of the nominal temperature versus time profile throughout the test, and an average tolerance of 2.0 °F over the duration of the test (where the average is calculated using the absolute value of each measured deviation). The control system shall be tuned to provide a smooth temperature pattern that has a minimum of overshoot, hunting, and instability about the desired long-term ambient temperature profile. Interior surface temperatures shall not be less than 40 °F at any time during the diurnal emission test. To accommodate the volume changes due to enclosure temperature changes, either a variable-volume or fixed-volume enclosure may be used for diurnal emission testing:

(i) *Variable-volume enclosure.* The variable-volume enclosure expands and contracts in response to the temperature change of the air mass in the enclosure. Two potential means of accommodating the internal volume changes are moveable panel(s), or a bellows design, in which imper-

meable bag(s) inside the enclosure expand and contract in response to internal pressure changes by exchanging air from outside the enclosure. Any design for volume accommodation must maintain the integrity of the enclosure as specified in § 86.1217-96 over the specified temperature range. Any method of volume accommodation shall limit the differential between the enclosure internal pressure and the barometric pressure to a maximum value of  $\pm 2.0$  inches of water. The enclosure shall be capable of latching to a fixed volume. A variable-volume enclosure must be capable of accommodating a  $\pm 7$  percent change from its "nominal volume" (see § 86.1217-96(b)), accounting for temperature and barometric pressure variation during testing.

(ii) *Fixed-volume enclosure.* The fixed-volume enclosure shall be constructed with rigid panels that maintain a fixed enclosure volume, and meet the following requirements.

(A) The enclosure shall be equipped with a mechanism to maintain a fixed internal air volume. This may be accomplished either by withdrawing air at a constant rate and providing makeup air as needed, or by reversing the flow of air into and out of the enclosure in response to rising or falling temperatures. If inlet air is added continuously throughout the test, it should be filtered with activated carbon to provide a relatively low and constant hydrocarbon level. Any method of volume accommodation shall maintain the differential between the enclosure internal pressure and the barometric pressure to a maximum value of  $\pm 2.0$  inches of water.

(B) The equipment shall be capable of measuring the mass of hydrocarbon and methanol (if the enclosure is used for methanol-fueled vehicles) in the inlet and outlet flow streams with a resolution of 0.01 gram per hour. A bag sampling system may be used to collect a proportional sample of the air withdrawn from and admitted to the enclosure. Alternatively, the inlet and outlet flow streams may be continuously analyzed using an on-line FID analyzer and integrated with the flow measurements to provide a continuous record of the mass hydrocarbon and methanol removal.

(2) *Running loss test.* The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with § 86.1217-96. The enclosure may be equipped with a personnel door, provided that the enclosure can still meet the requirements of § 86.1217-96 with the door installed. Interior surfaces must be impermeable and nonreactive to hydrocarbons and to methanol (if the enclosure is used for methanol-fueled vehicles). Interior surface temperatures shall not be less than 40 °F. If a running loss enclosure meets all the requirements of

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paragraph (a)(1) of this section, it may be used as a diurnal evaporative emission enclosure. The enclosure must contain a dynamometer that meets the requirements of § 86.1208. Provisions shall be made to remove exhaust gases from the enclosure. During the running loss test, ambient temperatures must be maintained at  $95 \pm 5$  °F ( $95 \pm 2$  °F on average). An air or oxygen cylinder with an attached self-contained breathing apparatus may be provided for the vehicle operator. The air required for vehicle operation shall be provided by one of the following methods:

(i) The running loss enclosure may be equipped to supply air to the vehicle, at a temperature of  $95 \pm 5$  °F, from sources outside of the running loss enclosure directly into the operating engine's air intake system. Supplemental air requirements (e.g., for an air pump) shall be supplied by drawing air from the engine intake source.

(ii) If it is shown to yield equivalent or superior results, the running loss enclosure may be designed with an air makeup system that brings outside air into the enclosure to accommodate the aspiration needs of the engine and any auxiliary devices. The makeup air shall be monitored to establish the background hydrocarbon levels (or hydrocarbon and methanol, levels, if applicable) of the makeup air. A filter may be used to provide dry air with a stable concentration of background hydrocarbon. The makeup-air vent shall be readily sealable for calibration of the enclosure and other purposes. For calculation of running loss emissions, it may be assumed that the hydrocarbon and methanol concentration in the air consumed by the vehicle is the same as that of the rest of the air in the enclosure.

(3) *Hot soak test.* The hot soak test may be conducted by holding the vehicle in an enclosure that meets the requirements for either diurnal emission or running loss tests. The enclosure shall be configured to provide an internal enclosure ambient temperature of  $95 \pm 10$  °F for the first 5 minutes, and  $95 \pm 5$  °F ( $95 \pm 2$  °F on average) for the remainder of the hot soak test.

(i) If the hot soak test is conducted in the same enclosure as the immediately preceding running loss test, interior surface temperatures shall not be below 70° F for the last 55 minutes of the hot soak test.

(ii) If the hot soak test is not conducted in the same enclosure as the immediately preceding running loss test, interior surface temperatures shall not be below 70° F for the duration of the hot soak test.

(b) *Evaporative emission hydrocarbon and methanol analyzers.* (1) For gasoline-, liquefied petroleum gas-, natural gas- and methanol-fueled vehicles a hydrocarbon analyzer utilizing the hydrogen flame ionization principle (FID) shall be

used to monitor the atmosphere within the enclosure (a heated FID (HFID)( $235 \pm 15$ °F ( $113 \pm 8$ °C)) is recommended for methanol-fueled vehicles). Provided evaporative emission results are not affected, a probe may be used to detect or verify hydrocarbon sources during a running loss test. Instrument bypass flow may be returned to the enclosure. The FID shall have a response time to 90 percent of final reading of less than 1.5 seconds.

(2) For methanol-fueled vehicles, a methanol sampling and analyzing system is required in addition to the FID analyzer. The methanol sampling equipment shall consist of impingers for collecting the methanol sample and appropriate equipment for drawing the sample through the impingers. The analytical equipment shall consist of a gas chromatograph equipped with a flame ionization detector.

(3) The methanol sampling system described in paragraph (b)(2) of this section shall be designed such that, if a test vehicle emitted the maximum allowable level of methanol (based on all applicable standards) during any phase of the test, the measured concentration in the primary impinger would exceed either 25 mg/l or a concentration equal to 25 times the limit of detection for the GC analyzer, and such that the primary impinger collects at least 90 percent of the analyte in the samples. The remaining analyte shall be collected by the secondary impinger. The provisions of this paragraph apply to the design of sampling systems, not to individual tests.

(c) *Evaporative emission hydrocarbon and methanol data recording system.* (1) The electrical output of the FID used for measuring hydrocarbons (or hydrocarbons plus methanol, as appropriate) shall be recorded at least at the initiation and termination of each running loss and hot soak test, and at least at the initiation and termination of the enclosure sampling period(s) for the diurnal emission test, as described in § 86.1233. The recording may be taken by means of a strip chart potentiometric recorder, by use of an on-line computer system or other suitable means. In any case, the recording system must have operational characteristics (signal-to-noise ratio, speed of response, etc.) equivalent to or better than those of the signal source being recorded, and must provide a permanent record of results. The record shall show a positive indication of the initiation and completion of each hot soak, running loss, or diurnal emission test (including initiation and completion of sampling period(s)), along with the time elapsed during each soak.

(2) For the methanol sample, permanent records shall be made of the following: the volumes of deionized water introduced into each impinger, the rate and time of sample collection and the chromatogram of the analyzed sample.

(d) *Fuel temperature control system.* Fuel temperatures of the test vehicle shall be controlled, as specified in § 86.1234(g)(1)(xv), with the following combination of fans. The control system shall be tuned and operated to provide a smooth and continuous fuel temperature profile that is representative of the on-road temperature profile. The running loss test configuration should be designed to avoid heating or cooling the fuel tank's vapor space in a way that would cause vapor temperature behavior to be unrepresentative of the vehicle's on-road profile.

(1) A vehicle cooling fan shall discharge air to the front of the vehicle. The fan shall be a road-speed modulated fan that is controlled to a discharge velocity that follows the dynamometer roll speed, at least up to speeds of 30 mph, throughout the driving cycle. If a warning light or gauge indicates that the vehicle's engine coolant has overheated, subsequent test runs on the that vehicle must include a vehicle cooling fan that follows the dynamometer roll speed at all speeds throughout the test cycle. The fan may direct airflow to both the vehicle radiator air inlet(s) and the vehicle underbody.

(2) An additional fan may be used to discharge airflow from the front of the vehicle directly to the vehicle underbody to control fuel temperatures. Such a fan shall provide a total discharge airflow not to exceed 8,000 cfm.

(3) Additional fans may be used to route heating or cooling air directly at the bottom of the vehicle's fuel tank. The air supplied to the tank shall be between 85° and 160° F, with a total discharge airflow not to exceed 4,000 cfm. For exceptional circumstances, manufacturers may direct up to 6,000 cfm at the bottom of the fuel tank with the advance approval of the Administrator.

(4) Direct fuel heating may be needed for canister preconditioning, as specified in § 86.1232(j)(2). Also, under exceptional circumstances in which airflow alone is insufficient to control fuel temperatures during the running loss test, direct fuel tank heating may be used (see § 86.1234-96(g)(1)(xv)). The heating system must not cause hot spots on the tank wetted surface that could cause local overheating of the fuel. Heat must not be applied directly to the tank's vapor space, nor to the liquid-vapor interface.

(e) *Temperature recording system.* A strip chart potentiometric recorder, an on-line computer system, or other suitable means shall be used to record enclosure ambient temperature during all evaporative emission test segments, as well as vehicle fuel tank temperature during the running loss test. The recording system shall record each temperature at least once every minute. The recording system shall be capable of resolving time to  $\pm 15$  s and capable of resolving temperature to  $\pm 0.75^\circ$

F ( $\pm 0.42^\circ$  C). The temperature recording system (recorder and sensor) shall have an accuracy of  $\pm 3^\circ$  F ( $\pm 1.7^\circ$  C). The recorder (data processor) shall have a time accuracy of  $\pm 15$  s and a precision of  $\pm 15$  s. Enclosures shall be equipped with two ambient temperature sensors, connected to provide one average output, located 3 feet above the floor at the approximate mid-length of each side wall of the enclosure and within 3 to 12 inches of each side wall. For diurnal emission testing, an additional temperature sensor shall be located underneath the vehicle to provide a temperature measurement representative of the air temperature under the fuel tank. For running loss testing, an ambient temperature sensor shall be located at the inlet to the fan that provides engine cooling. Manufacturers shall arrange that vehicles furnished for testing at federal certification facilities be equipped with temperature sensors for measurement of fuel tank temperatures. Vehicles shall be equipped with two temperature sensors installed to provide an average liquid fuel temperature. The temperature sensors shall be placed to measure the temperature at the mid-volume of the liquid fuel at a fill level of 40 percent of nominal tank capacity. An additional temperature sensor may be placed to measure vapor temperatures approximately at the mid-volume of the vapor space, though measurement of vapor temperatures is optional during the running loss test. In-tank temperature sensors are not required for the supplemental two-diurnal test sequence specified in § 86.1230-96.

(f) *Pressure recording system.* A strip chart potentiometric recorder, an on-line computer system, or other suitable means, shall be used to record the enclosure gage pressure for any testing in an enclosure, as well as the vehicle's fuel tank pressure during the running loss test and the outdoor driving procedure specified in § 86.1229-85(d). Fuel tank pressure measurement and recording equipment are optional during the running loss test. The recording system shall record each pressure at least once every minute. The recording system shall be capable of resolving time to  $\pm 15$  s and capable of resolving pressure to  $\pm 0.1$  inches of water. The pressure recording system (recorder and sensor) shall have an accuracy of  $\pm 1.0$  inch of water. The recorder (data processor) shall have a time accuracy of  $\pm 15$  s and a precision of  $\pm 15$  s. The pressure transducer shall be installed to measure the pressure in the vapor space of the fuel tank.

(g) *Purge blower.* One or more portable or fixed blowers shall be used to purge the enclosure. The blowers shall have sufficient flow capacity to reduce the enclosure hydrocarbon and/or methanol concentration from the test level to the ambient

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level between tests. Actual flow capacity will depend upon the time available between tests.

(h) *Mixing blower.* Blowers or fans shall be used to mix the enclosure contents during evaporative emission testing. The inlets and outlets of the air circulation blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon stratification. Maintenance of uniform concentrations throughout the enclosure is important to the accuracy of testing.

(1) *Diurnal emission test.* Blowers or fans shall have a capacity of  $0.8 \pm 0.2$  cfm per cubic foot of the nominal enclosure volume for mixing in the enclosure. Additional fans may be used to maintain a minimum wind speed of 5 mph (8 km/h) under the fuel tank of the test vehicle.

(2) *Running loss test.* Blowers or fans shall have a total capacity of at least 1.0 cfm per cubic foot of the nominal enclosure volume.

(3) *Hot soak test.* Blowers or fans must have a capacity of  $0.8 \pm 0.2$  cfm per cubic foot of the nominal enclosure volume. Circulated air shall not be aimed directly at the vehicle.

(i) *Point-source running loss measurement facility.* Some system requirements pertain specifically to running loss testing by the point-source method, in which emissions from potential sources are collected and routed to a sampling system. Emissions are sampled with the same equipment and techniques as for exhaust emission measurement. The test environment must contain a dynamometer that meets the requirements of § 86.108. During the running loss test, ambient temperatures must be maintained at  $95 \pm 5$  °F ( $95 \pm 2$  °F on average). An air or oxygen cylinder with an attached self-contained breathing apparatus may be provided for the vehicle operator.

(1) The running loss vapor vent collection system shall be configured to collect all running loss emissions from each of the discrete point sources that function as vehicle fuel system vapor vents, and transport the collected vapor emissions to a CFV- or PDP-based dilution and measurement system. The collection system shall consist of a collector at each vehicle vapor vent, lengths of heated sample line connecting each collector to the inlet of the heated sample pump, and lengths of heated sample line connecting the outlet of the heated sample pump to the inlet of the running loss fuel vapor sampling system. Up to 3 feet of unheated line connecting each of the vapor collectors to the heated sample lines shall be allowed. Each heated sample pump and its associated sample lines shall be maintained at a temperature between 175 °F and 200 °F to prevent condensation of fuel vapor in the sample lines. The heated sample pump(s) and its associated flow controls shall

be configured and operated to draw a flow of ambient air into each collector at a flow rate of at least 0.67 cfm. The flow controls on each heated sampling system shall include an indicating flow meter that provides an alarm output to the data recording system if the flow rate drops below 0.67 cfm by more than 5 percent. The collector inlet for each discrete vapor vent shall be placed in proximity to the vent as necessary to capture any fuel vapor emissions without significantly affecting flow or pressure of the normal action of the vent. The collector inlets shall be designed to interface with the configuration and orientation of each specific vapor vent. For vapor vents that terminate in a tube or hose barb, a short length of tubing of an inside diameter larger throughout its length than the inside diameter of the vent outlet may be used to extend the vent into the mouth of the collector. For those vapor vent designs that are not compatible with such collector configurations, the vehicle manufacturer shall supply a collector that is configured to interface with the vapor vent design and that terminates in a fitting that is capable of capturing all vapor emitted from the vent. The Administrator may test for running losses by the point-source method without heating sample lines or pumps.

(2) The running loss fuel vapor sampling system shall be a CFV- or PDP-based dilution and measurement system that further dilutes the running loss fuel vapors collected by the vapor vent collection system(s) with ambient air, collects continuously proportional samples of the diluted running loss vapors and dilution air in sample bags, and measures the total dilute flow through the sampling system over each test interval. In practice, the system shall be configured and operated in a manner that is directly analogous to an exhaust emissions constant volume sampling system, except that the input flow to the system is the flow from the running loss vapor vent collection system(s) instead of vehicle exhaust flow. The system shall be configured and operated to meet the following requirements:

(i) The running loss fuel vapor sampling system shall be designed to measure the true mass of fuel vapor emissions collected by the running loss vapor vent collection system from the specified fuel vapor vents. The total volume of the mixture of running loss emissions and dilution air shall be measured and a continuously proportioned sample of volume shall be collected for analysis. Mass emissions shall be determined from the sample concentration and total flow over the test period.

(ii) The PDP-CVS shall consist of a dilution air filter and mixing assembly, heat exchanger, positive-displacement pump, sampling system, and associated valves, pressure and temperature sensors.

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The PDP-CVS shall conform to the following requirements:

(A) The gas mixture temperature, measured at a point immediately ahead of the positive-displacement pump, shall be within  $\pm 10$  °F of the designed operating temperature at the start of the test. The gas mixture temperature variation from its value at the start of the test shall be limited to  $\pm 10$  °F during the entire test. The temperature measuring system shall have an accuracy and precision of  $\pm 2$  °F.

(B) The pressure gauges shall have an accuracy and precision of  $\pm 1.6$  inches of water ( $\pm 0.4$  kPa).

(C) The flow capacity of the CVS shall not exceed 350 cfm.

(D) Sample collection bags for dilution air and running loss fuel vapor samples shall be sufficient size so as not to impede sample flow.

(iii) The CFV sample system shall consist of a dilution air filter and mixing assembly, a sampling venturi, a critical flow venturi, a sampling system and assorted valves, and pressure and temperature sensors. The CFV sample system shall conform to the following requirements:

(A) The temperature measuring system shall have an accuracy and precision of  $\pm 2$  °F and a response time of 0.100 seconds of 62.5 percent of a temperature change (as measured in hot silicone oil).

(B) The pressure measuring system shall have an accuracy and precision of  $\pm 1.6$  inches of water (0.4 kPa).

(C) The flow capacity of the CVS shall not exceed 350 cfm.

(D) Sample collection bags for dilution air and running loss fuel vapor samples shall be of sufficient size so as not to impede sample flow.

(3) An on-line computer system or strip-chart recorder shall be used to record the following additional parameters during the running loss test sequence:

- (i) CFV (if used) inlet temperature and pressure.
- (ii) PDP (if used) inlet temperature, pressure, and differential pressure.

[58 FR 16047, Mar. 24, 1993, as amended at 59 FR 48521, Sept. 21, 1994; 60 FR 34358, June 30, 1995; 60 FR 43898, Aug. 23, 1995]

### § 86.1213-90 Fuel specifications.

(a) Gasoline having the following specifications will be used in emissions testing for gasoline-fueled vehicles.

Item	ASTM	Value
Octane, research, min .....	D2699	93
Sensitivity, min .....		7.5
Lead (organic), g/U.S. gal .....	D3237	0.050[1]
(g/liter) .....		(0.013)[1]
Distillation range:		
IBP, °F .....	D86	75-95
(°C) .....		(23.9-35)

Item	ASTM	Value
10 pct. point, °F .....	D86	120-135
(°C) .....		(48.9-57.2)
50 pct. point, °F .....	D86	200-230
(°C) .....		(93.3-110)
90 pct. point, °F .....	D86	300-325
(°C) .....		(148.9-162.8)
EP, max. °F .....	D86	415
(°C) .....		(212.8)
Sulphur, max. wt. pct .....	D1266	0.10
Phosphorous, max. g/U.S. gal .....	D3231	0.005
(g/liter) .....		(0.0013)
RVP, psi .....	D323	8.7-9.2
(kPa) .....		(60.0-63.4)
Hydrocarbon composition:		
Olefins, max. pct .....	D1319	10
Aromatics, max. pct .....	D1319	35
Saturates .....	D1319	[2]

[1] Maximum.

[2] Remainder.

(b)(1) Unleaded gasoline representative of commercial gasoline which will be generally available through retail outlets shall be used in service accumulation.

(2) The octane rating of the gasoline used shall be no higher than 1.0 Research octane number above the minimum recommended by the manufacturer and have a minimum sensitivity of 7.5 octane numbers, where sensitivity is defined as the Research octane number minus the Motor octane number.

(3) The Reid Vapor Pressure of the gasoline used shall be characteristic of the motor fuel used during the season in which the service accumulation takes place.

(c) Methanol fuel used in evaporative emission testing and in service accumulation of methanol-fueled vehicles shall be representative of commercially available methanol fuel and shall consist of at least 50 percent methanol (CH<sub>3</sub>OH) by volume.

(1) Manufacturers shall recommend the methanol fuel to be used for testing and service accumulation in accordance with paragraph (c) of this section.

(2) The Administrator shall determine the methanol fuel to be used for testing and service accumulation.

(d) Other methanol fuels may be used for testing and service accumulation provided:

- (1) They are commercially available, and
- (2) Information, acceptable to the Administrator, is provided to show that only the designated fuel would be used in customer service, and
- (3) Use of a fuel listed under paragraph (c)(2) of this section would have a detrimental effect on emissions or durability, and

(4) Written approval from the Administrator of the fuel specifications must be provided prior to the start of testing.

(e) The specification range of the fuels to be used under paragraphs (b), (c), and (d) of this sec-

## § 86.1213-94

tion shall be reported in accordance with § 86.090-21(b)(3).

(f) *Mixtures of petroleum and methanol fuels for flexible fuel vehicles.* (1) Mixtures of petroleum and methanol fuels used for exhaust and evaporative emission testing and service accumulation for flexible fuel vehicles shall be within the range of fuel mixtures for which the vehicle was designed.

(2) Manufacturer testing and service accumulation may be performed using only those mixtures (mixtures may be different for exhaust testing, evaporative testing, and service accumulation) expected to result in the highest emissions, provided:

(i) The fuels which constitute the mixture will be used in customer service, and

(ii) Information, acceptable to the Administrator, is provided by the manufacturer to show that the designated fuel mixtures would result in the highest emissions, and

(iii) Written approval from the Administrator of the fuel specifications must be provided prior to the start of testing.

(3) The specification range of the fuels to be used under paragraph (f)(2) of this section shall be reported in accordance with § 86.090-21(b)(3).

[53 FR 476, Jan. 7, 1988, as amended at 54 FR 14563, Apr. 11, 1989]

### § 86.1213-94 Fuel specifications.

(a) *Gasoline fuel.* (1) Gasoline having the following specifications will be used in emissions testing for gasoline-fueled vehicles.

Item	ASTM test method No.	Value
Octane, research, min. ....	D2699	93
Sensitivity, min. ....		7.5
Lead (organic) g/U.S. gal ....	D3237	<sup>1</sup> 0.050
(g/liter) ....		<sup>1</sup> (0.013)
Distillation range:		
IBP °F ....	D86	75-95
(°C) ....		(23.9-35)
10 pct. point °F ....	D86	120-135
(°C) ....		(48.9-57.2)
50 pct. point °F ....	D86	200-230
(°C) ....		(93.3-110)
90 pct. point °F ....	D86	300-325
(°C) ....		(148.9-162.8)
EP, max. °F ....	D86	415
(°C) ....		(212.8)
Sulphur, max. wt. pct. ....	D1266	0.10
Phosphorous, max. g/U.S. gal. ....	D3231	0.005
(g/liter) ....		(0.0013)
RVP, psi. ....	D323	8.7-9.2
(kPa) ....		(60.0-63.4)
Hydrocarbon composition:		
Olefins, max. pct. ....	D1319	10
Aromatics, max. pct. ....	D1319	35
Saturates ....	D1319	( <sup>2</sup> )

<sup>1</sup> Maximum.

<sup>2</sup> Remainder.

(2) (i) Unleaded gasoline representative of commercial gasoline which will be generally available through retail outlets shall be used in service accumulation.

(ii) The octane rating of the gasoline used shall be no higher than 1.0 Research octane number above the minimum recommended by the manufacturer and have a minimum sensitivity of 7.5 octane numbers, where sensitivity is defined as the Research octane number minus the Motor octane number.

(iii) The Reid Vapor Pressure of the gasoline used shall be characteristic of the motor fuel used

during the season in which the service accumulation takes place.

(3) The specification range of the gasoline to be used under paragraphs (a)(1) and (a)(2) of this section shall be reported in accordance with § 86.094-21(b)(3).

(b) *Methanol fuel.* (1) Methanol fuel used in evaporative emission testing and in service accumulation of methanol-fueled vehicles shall be representative of commercially available methanol fuel and shall consist of at least 50 percent methanol (CH<sub>3</sub>OH) by volume.



(i) Manufacturers shall recommend the methanol fuel to be used for testing and service accumulation.

(ii) The Administrator shall determine the methanol fuel to be used for testing and service accumulation.

(2) Other methanol fuels may be used for testing and service accumulation provided:

(i) They are commercially available;

(ii) Information, acceptable to the Administrator, is provided to show that only the designated fuel would be used in customer service; and

(iii) Use of a fuel listed under paragraph (b)(1) of this section would have a detrimental effect on emissions or durability; and

(iv) Written approval from the Administrator of the fuel specifications must be provided prior to the start of testing.

(3) The specification range of the methanol fuels to be used under paragraphs (b)(1) and (b)(2) of this section shall be reported in accordance with § 86.094-21(b)(3).

(c) *Mixtures of petroleum and methanol fuels for flexible fuel vehicles.* (1) Mixtures of petroleum and methanol fuels used for exhaust and evaporative emission testing and service accumulation for flexible fuel vehicles shall consist of the gasoline listed in paragraph (a) of this section and the methanol fuel listed in paragraph (b) of this section, and shall be within the range fuel mixtures for which the vehicle was designed as reported in accordance with § 86.94-21. The Administrator may use any fuel within this range for testing.

(2) The fuel mixtures used by the manufacturers shall be sufficient to demonstrate compliance over the full design range, and shall include:

(i) For emission testing:

(A) The petroleum fuel specified in paragraph (a) of this section;

(B) A methanol fuel representative of the methanol fuel expected to be found in use, as specified in paragraph (d) of this section; and

(C) A combination of the fuels specified in paragraphs (c)(2)(i)(A) and (B) of this section that represents the composition which results in the highest Reid Vapor Pressure for the mixture. The mixture shall contain between nine and thirteen percent methanol.

(ii) For service accumulation, an alternating combination of the fuels specified in paragraphs (a) and (b) of this section that, based on good engineering judgement, demonstrates the durability of the emission control system. The fuels may be used as a single mixture or alternated.

(iii) Or, other combinations for testing or service accumulation which demonstrate compliance with the standards over the entire design range of the vehicle, provided that written approval is ob-

tained from the Administrator prior to the start of testing.

(3) The specification range of the fuels to be used under paragraph (c) of this section shall be reported in accordance with § 86.094-21.

(d) *Natural gas fuel.* (1) Natural gas fuel having the following specifications will be used in evaporative emission testing and in service accumulation of natural gas-fueled vehicles shall be commercially available natural gas fuel.

#### NATURAL GAS CERTIFICATION FUEL SPECIFICATIONS

Item		ASTM test method No.	Value
Methane .....	min. mole pct	D1945	89.0
Ethane .....	max. mole pct	D1945	4.5
C <sub>3</sub> and higher .....	max. mole pct	D1945	2.3
C <sub>4</sub> and higher .....	max. mole pct	D1945	0.2
Oxygen .....	max. mole pct	D1945	0.6
Inert gases: Sum of CO <sub>2</sub> and N <sub>2</sub>	max. mole pct	D1945	4.0
Odorant <sup>1</sup>			

<sup>1</sup> The natural gas at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability.

(2) Natural gas fuel representative of commercial natural gas which will be generally available through retail outlets shall be used in service accumulation.

(3) Other natural gas fuels may be used for emission testing and service accumulation provided:

(i) They are commercially available;

(ii) Information, acceptable to the Administrator, is provided to show that only the designated fuel would be used in customer service; and

(iii) Written approval from the Administrator of the fuel specifications must be provided prior to the start of testing.

(4) The specification range of the fuels to be used under paragraphs (d)(1), (d)(2) and (d)(3) of this section shall be reported in accordance with § 86.094-21(b)(3).

(e) *Liquefied petroleum gas-fuel.* (1) Liquefied petroleum gas-fuel used in evaporative emission testing and in service accumulation of liquefied petroleum gas-fueled vehicles shall be commercially available liquefied petroleum gas-fuel.

(i) Manufacturers shall recommend the liquefied petroleum gas-fuel to be used for testing and service accumulation.

(ii) The Administrator shall determine the liquefied petroleum gas-fuel to be used for testing and service accumulation.

(2) Other liquefied petroleum gas fuels may be used for testing and service accumulation provided:

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- (i) They are commercially available;
  - (ii) Information, acceptable to the Administrator, is provided to show that only the designated fuel would be used in customer service; and
  - (iii) Written approval from the Administrator of the fuel specifications must be provided prior to the start of testing.
- (3) The specification range of the fuels to be used under paragraphs (e)(1) and (e)(2) of this section shall be measured in accordance with ASTM D2163-91 and reported in accordance with § 86.094-21(b)(3).

[59 FR 48521, Sept. 21, 1994, as amended at 34359, June 30, 1995]

### § 86.1214-85 Analytical gases.

- (a) *Analyzer gases.* (1) Gases for the hydrocarbon analyzer shall be:
- (i) Single blends of propane using air as the diluent; and
  - (ii) Optionally, for response factor determination, single blends of methanol using air as the diluent.
- (2) Fuel for the evaporative emission enclosure FID (or HFID for methanol-fueled vehicles) shall be a blend of 40  $\pm$ 2 percent hydrogen with the balance being helium. The mixture shall contain less than 1 ppm equivalent carbon response. 98 to 100 percent hydrogen fuel may be used with advance approval by the Administrator.
- (3) The allowable zero air impurity concentration shall not exceed 1 ppm equivalent carbon response.
- (4) "Zero grade air" includes artificial "air" consisting of a blend of nitrogen and oxygen with oxygen concentrations between 18 and 21 mole percent.
- (5) The use of proportioning and precision blending devices to obtain the required analyzer gas concentrations is allowable provided their use has been approved in advance by the Administrator.
- (b) Calibration gases (not including methanol) shall be traceable to within one percent of NIST (formerly NBS) gas standards, or other gas standards which have been approved by the Administrator.
- (c) Span gases (not including methanol) shall be accurate to within two percent of true concentration, where true concentration refers to NIST (formerly NBS) gas standards, or other gas standards which have been approved by the Administrator.
- (d) Methanol in air gases used for response factor determination shall:
- (1) Be traceable to within  $\pm$ 2 percent of NIST (formerly NBS) gas standards, or other gas standards which have been approved by the Administrator; and

- (2) Remain within  $\pm$ 2 percent of the labeled concentration. Demonstration of stability shall be based on a quarterly measurement procedure with a precision of  $\pm$ 2 percent (two standard deviations), or other method approved by the Administrator. The measurement procedure may incorporate multiple measurements. If the true concentration of the gas changes by more than two percent, but less than ten percent, the gas may be relabeled with the new concentration.

[48 FR 1456, Jan. 12, 1983, as amended at 60 FR 34359, June 30, 1995]

### § 86.1215-85 EPA heavy-duty vehicle (HDV) urban dynamometer driving schedule.

- (a) The EPA dynamometer driving schedule for heavy-duty vehicles is a 1060 second transient speed versus time cycle which is designed to simulate gasoline-fueled HDV operation in urban areas. A second by second listing of this schedule is given in appendix I(d) of this part. Thirty-three percent of the cycle is idle operation, and the average vehicle speed is 18.9 mph (30.4 km/hr). The Administrator will use this driving schedule when conducting evaporative emission tests, as described in § 86.1230-96.
- (b) The driver should attempt to follow the target schedule as closely as possible. The speed tolerance at any given time for these schedules, or for a driver's aid chart approved by the Administrator, are as follows:
- (1) The upper limit is 4 mph (6.4 km/h) higher than the highest point on the trace within 1 second of the given time.
  - (2) The lower limit is 4 mph (6.4 km/h) lower than the lowest point on the trace within 1 second of the given time.
  - (3)(i) Speed variations greater than the tolerances (such as may occur during gear changes or braking spikes) are acceptable, provided they occur for less than 2 seconds on any occasion and are clearly documented as to the time and speed at that point of the driving schedule.
  - (ii) When conducted to meet the requirements of § 86.1229, up to three additional occurrences of speed variations greater than the tolerance are acceptable, provided they occur for less than 15 seconds on any occasion, and are clearly documented as to the time and speed at that point of the driving schedule.
  - (4) Speeds lower than those prescribed are acceptable, provided the vehicle is operated at maximum available power during such occurrences.

[48 FR 1456, Jan. 12, 1983, as amended at 58 FR 16050, Mar. 24, 1993]

**§ 86.1216-90 Calibrations; frequency and overview.**

(a) Calibrations shall be performed as specified in § 86.1217 through § 86.1226.

(b) At least yearly or after any maintenance which could alter background emission levels, enclosure background emission measurements shall be performed.

(c) At least monthly or after any maintenance which could alter calibration, the following calibrations and checks shall be performed:

(1) Calibrate the hydrocarbon analyzer (see § 86.1221). Certain analyzers may require more frequent calibration depending on particular equipment and uses.

(2) Calibrate the dynamometer. If the dynamometer receives a weekly performance check (and remains within calibration) the monthly calibration need not be performed (see § 86.1218).

(3) Perform a hydrocarbon retention check and calibration on the evaporative emission enclosure (see § 86.1217).

(d) At least twice annually or after any maintenance perform a methanol retention check and calibration on the evaporative emission enclosure (see § 86.1217).

(e) Calibrate the methanol analyzer as often as required by the manufacturer or as necessary according to good practice.

[54 FR 14564, Apr. 11, 1989, as amended at 60 FR 34359, June 30, 1995]

**§ 86.1217-90 Evaporative emission enclosure calibrations.**

The calibration of the evaporative emission enclosure consists of three parts: Initial and periodic determination of enclosure background emissions (hydrocarbons and methanol); initial determination of enclosure internal volume; and periodic hydrocarbon and methanol retention check and calibration. Methanol measurements may be omitted when methanol-fueled vehicles will not be tested in the evaporative enclosure.

(a) *Initial and periodic determination of enclosure background emissions.* Prior to its introduction into service, annually thereafter, and after any repair which can affect the enclosure background emissions, the enclosure shall be checked to determine that it does not contain materials which will themselves emit hydrocarbons or methanol.<sup>1</sup> Proceed as follows:

<sup>1</sup> NOTE: When methanol as well as hydrocarbons are present in the evaporative enclosure, the HFID hydrocarbon concentration measurement includes the partial response of the HFID to methanol plus the hydrocarbons. Determination of the HFID response to methanol, § 86.1221, prior to its being placed in service is required for the determination of hydrocarbons.

(1) Zero and span (calibrate if required) the hydrocarbon analyzer.

(2) Purge the enclosure until a stable background hydrocarbon reading is obtained.

(3) Turn on the mixing blower (if not already on).

(4) Seal enclosure and measure background hydrocarbon concentration, background methanol, temperature, and barometric pressure. These are the initial readings  $C_{HCl}$ ,  $C_{CH_3OH}$ ,  $T_i$ , and  $P_{Bi}$  for the enclosure background determination.

(5) Allow the enclosure to stand undisturbed without sampling for four hours.

(6) Measure the hydrocarbon and methanol concentration on the same FID. These are the final concentrations,  $C_{HCl}$  and  $C_{CH_3OH}$ . Also measure final temperature and barometric pressure.

(7) Calculate the mass change of methanol, hydrocarbons, and hydrocarbons plus methanol in the enclosure according to the equations in paragraph (d) of this section. The enclosure background emissions (hydrocarbons plus methanol) shall not be greater than 0.4g for the 4 hours.

(b) *Initial determination of enclosure internal volume.* Prior to its introduction into service the enclosure internal volume shall be determined by the following procedure.

(1) Carefully measure the internal length, width and height of the enclosure, accounting for irregularities (such as braces) and calculate the internal volume.

(2) Perform an enclosure calibration check according to paragraphs (c) (1) through (7) of this section.

(3) If the calculated mass does not agree within  $\pm 2$  percent of the injected propane mass, then corrective action is required.

(c) *Hydrocarbon and methanol retention check and calibration.* The hydrocarbon and methanol retention check provides a check upon the calculated volume and also measures the leak rate. Prior to its introduction into service and at least monthly thereafter the enclosure leak rate shall be determined as follows:

(1) Zero and span (calibrate if required) the hydrocarbon analyzer.

(2) Purge the enclosure until a stable background hydrocarbon reading is obtained.

(3) Turn on the mixing blower (if not already on).

(4) Seal enclosure and measure background hydrocarbon concentration, background methanol, temperature, and barometric pressure. These are the initial readings  $C_{HCl}$ ,  $C_{CH_3OH}$ ,  $T_i$  and  $P_{Bi}$  for the enclosure calibration.

(5) Inject into the enclosure a known quantity of pure propane (4g is a convenient quantity) and a known quantity of pure methanol (4g is a convenient quantity) in gaseous form; i.e., at a tempera-

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ture of at least 150–155°F (65–68°C). The propane and methanol may be measured by volume flow or by mass measurement. The method used to measure the propane and methanol shall have an accuracy of  $\pm 0.5$  percent of the measured value. (Less accurate methods may be used with the advanced approval of the Administrator.) The methanol and propane tests do not need to be conducted simultaneously.

(6) After a minimum of 5 minutes of mixing, analyze the enclosure atmosphere for hydrocarbon and methanol content, also record temperature and pressure. These measurements are the final readings for the enclosure calibration as well as the initial readings for the retention check.

(7) To verify the enclosure calibration, calculate the mass of propane and the mass of methanol using the measurements taken in steps (4) and (6). See paragraph (d) of this section. This quantity must be within  $\pm 2$  percent of that measured in step 5 above. (For 1991–1995 calendar years, the difference may exceed  $\pm 2$  percent for methanol, provided it does not exceed  $\pm 6$  percent.)

(8) Allow the enclosure to remain sealed for a minimum of 4 hours, analyze the enclosure atmosphere for hydrocarbon and methanol content; record temperature and barometric pressure. These are the final readings for the hydrocarbon and methanol retention check.

(9) Calculate, using the equation in paragraph (d) of this section and the readings taken in step (8), the hydrocarbon and methanol mass. It may not differ by more than  $\pm 4$  percent of the value in step (6). (For 1991–1995 calendar year methanol-fueled vehicles, the difference may exceed  $\pm 4$  percent for methanol, provided it does not exceed  $\pm 6$  percent.)

(d) *Calculations.* (1) The calculation of net methanol and hydrocarbon mass change is used to determine enclosure background and leak rate. It is also used to check the enclosure volume measurements. The methanol mass change is calculated from the initial and final methanol samples, temperature and pressure according to the following equation:

ER06OC93.117

Where:

- (i)  $M_{CH_3OH}$  = Methanol mass change,  $\mu\text{g}$ .
- (ii)  $V$  = Enclosure volume,  $\text{ft}^3$ , as measured in paragraph (b)(1) of this section.
- (iii)  $T_E$  = Temperature of sample withdrawn,  $^{\circ}\text{R}$ .
- (iv)  $V_E$  = Volume of sample withdrawn,  $\text{ft}^3$ .
- (v)  $P_B$  = Barometric pressure at time of sampling, in. Hg.
- (vi)  $C_{MS}$  = GC concentration of test sample.
- (vii)  $AV$  = Volume of absorbing reagent in impinger.
- (viii)  $i$  = Initial sample.
- (ix)  $f$  = Final sample.

(x) 1 = First impinger.

(xi) 2 = Second impinger.

(2) The hydrocarbon mass change is calculated from the initial and final FID readings of hydrocarbon concentration, methanol concentration with FID response to methanol, temperature, and pressure according to the following equation:

ER06OC93.118

Where:

- (i)  $M_{HC}$  = Hydrocarbon mass change, g.
- (ii)  $C_{HC}$  = FID hydrocarbon concentration as ppm carbon including FID response to methanol in the sample.
- (iii)  $C_{CH_3OH}$  = Methanol concentration as ppm carbon.
- ER06OC93.119
- (iv)  $V$  = Enclosure volume,  $\text{ft}^3$  ( $\text{m}^3$ ), as measured in paragraph (b)(1) of this section.
- (v)  $r$  = FID response factor to methanol.
- (vi)  $P_B$  = Barometric pressure, in. Hg (kPa).
- (vii)  $T$  = Enclosure ambient temperature,  $^{\circ}\text{R}$  ( $^{\circ}\text{K}$ ).
- (viii)  $i$  = Indicates initial reading.
- (ix)  $f$  = Indicates final reading.
- (x) (A)  $k = 3.05$
- (B) *For SI units*,  $k = 17.60$

NOTE: Hydrocarbon concentration is stated in ppm carbon, that is, ppm propane  $\times 3$ . Expressions in parentheses are for SI units.

[54 FR 14564, Apr. 11, 1989, as amended at 60 FR 34359, June 30, 1995]

## § 86.1217-96 Evaporative emission enclosure calibrations.

The calibration of evaporative emission enclosures consists of three parts: initial and periodic determination of enclosure background emissions (hydrocarbons and methanol); initial determination of enclosure internal volume; and periodic hydrocarbon and methanol retention check and calibration. Methanol measurements may be omitted if methanol-fueled vehicles will not be tested in the evaporative enclosure. Alternate calibration methods may be used if shown to yield equivalent or superior results, and if approved in advance by the Administrator; specifically, more extreme temperatures may be used for determining calibration without affecting the validity of test results.

(a) *Initial and periodic determination of enclosure background emissions.* Prior to its introduction into service, annually thereafter, and after any repair that can affect the enclosure background emissions, the enclosure shall be checked to determine that it does not contain materials that will themselves emit hydrocarbons or methanol. When methanol as well as hydrocarbons are present in the evaporative enclosure, the HFID hydrocarbon concentration measurement includes the partial response of the HFID to methanol plus the hydro-

carbons. Determination of the HFID response to methanol, § 86.1221, prior to its being placed in service is required for the determination of hydrocarbons. Proceed as follows:

(1) Prepare the enclosure. (i) Variable-volume enclosures may be operated in either latched or unlatched volume configuration, as described in paragraph (b)(1) of this section. Ambient temperatures shall be maintained at  $96 \pm 3^\circ \text{F}$  throughout the 4-hour period.

(ii) Fixed-volume enclosures may be operated with inlet and outlet flow streams either closed or open; if inlet and outlet flow streams are open, the air flowing into and out of the enclosure must be monitored in accordance with § 86.107-96(a)(1)(ii)(B). Ambient temperatures shall be maintained at  $96 \pm 3^\circ \text{F}$  throughout the 4-hour period.

(iii) For running loss enclosures ambient temperatures shall be maintained at  $95 \pm 3^\circ \text{F}$  throughout the 4-hour period. For running loss enclosures designed with a vent for makeup air, the enclosure shall be operated with the vent closed.

(2) The enclosure may be sealed and the mixing fan operated for a period of up to 12 hours before the 4-hour background sampling period begins.

(3) Zero and span (calibrate if required) the hydrocarbon analyzer.

(4) Prior to the background determination, purge the enclosure until a stable background hydrocarbon reading is obtained.

(5) Turn on the mixing blower (if not already on).

(6) Seal enclosure and measure background hydrocarbon concentration, background methanol, temperature, and barometric pressure. These are the initial readings  $C_{\text{HCl}}$ ,  $C_{\text{CH}_3\text{OH}_i}$ , and  $P_{\text{Bi}}$ ,  $T_i$  for the enclosure background determination.

(7) Allow the enclosure to stand undisturbed for four hours.

(8) Measure the hydrocarbon concentration on the same FID and the methanol level. These are the final concentrations,  $C_{\text{HCl}_f}$  and  $C_{\text{CH}_3\text{OH}_f}$ . Also measure final temperature and barometric pressure.

(9) Calculate the mass change of methanol, hydrocarbons, and hydrocarbons plus methanol in the enclosure according to the equations in paragraph (d) of this section.

(i) *Diurnal enclosures.* The enclosure background emissions (hydrocarbons plus methanol) shall not be greater than 0.05g for the 4 hours.

(ii) *Running loss enclosures.* The enclosure background emissions (hydrocarbons plus methanol) shall not be greater than 0.2 grams for the 4 hours.

(b) *Initial determination of enclosure internal volume.* Prior to its introduction into service the enclosure internal volume shall be determined by the following procedure:

(1) Carefully measure the internal length, width and height of the enclosure, accounting for irregularities (such as braces) and calculate the internal volume. For variable-volume enclosures, latch the enclosure to a fixed volume when the enclosure is held at a constant temperature; this nominal volume shall be repeatable within  $\pm 0.5$  percent of the reported value.

(2)-(3) [Reserved].

(c) *Hydrocarbon and methanol (organic gas) retention check and calibration.* The hydrocarbon and methanol (if the enclosure is used for methanol-fueled vehicles) retention check provides a check upon the calculated volume and also measures the leak rate. The enclosure leak rate shall be determined prior to its introduction into service, following any modifications or repairs to the enclosure that may affect the integrity of the enclosure, and at least monthly thereafter. If six consecutive monthly retention checks are successfully completed without corrective action, the enclosure leak rate may be determined quarterly thereafter as long as no corrective action is required.

(1) An enclosure to be used for the diurnal emission test (see § 86.1233-96) shall be calibrated according to the following procedure. Calibration for hydrocarbon and methanol may be conducted simultaneously or in sequential test runs.

(i) Zero and span (calibrate if required) the hydrocarbon analyzer.

(ii) Purge the enclosure until a stable background hydrocarbon reading is obtained.

(iii) Turn on the mixing blowers (if not already on).

(iv) [Reserved].

(v) Turn on the ambient temperature control system (if not already on) and adjust it for an initial temperature of  $96^\circ \text{F}$  ( $36^\circ \text{C}$ ). On variable-volume enclosures, latch the enclosure to the appropriate volume position for the set temperature. On fixed-volume enclosures close the outlet and inlet flow streams.

(vi) When the enclosure stabilizes at  $96 \pm 3^\circ \text{F}$  ( $36 \pm 2^\circ \text{C}$ ), seal the enclosure and measure background hydrocarbon concentration, background methanol, temperature, and barometric pressure. These are the initial readings  $C_{\text{HCl}_i}$ ,  $C_{\text{CH}_3\text{OH}_i}$ ,  $T_i$ , and  $P_{\text{Bi}}$  for the enclosure calibration.

(vii) Inject into the enclosure 2 to 6 grams of pure methanol at a temperature of at least  $150^\circ \text{F}$  ( $65^\circ \text{C}$ ) and/or 2 to 6 grams of pure propane. The injected quantity may be measured by volume flow or by mass measurement. The method used to measure the quantity of methanol and propane shall have an accuracy of  $\pm 0.2$  percent of the measured value (less accurate methods may be used with the advance approval of the Administrator).

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(viii) After a minimum of 5 minutes of mixing, analyze the enclosure atmosphere for hydrocarbon and methanol content, also record temperature and pressure. These measurements are the final readings for the enclosure calibration as well as the initial readings for the retention check.

(ix) To verify the enclosure calibration, calculate the mass of propane and the mass of methanol using the measurements taken in paragraphs (c)(1)(vi) and (viii) of this section. See paragraph (d) of this section. This quantity must be within  $\pm 2$  percent of that measured in paragraph (c)(1)(vii) of this section. (For calendar years through 1995, the difference may exceed  $\pm 2$  percent for methanol, provided it does not exceed  $\pm 6$  percent.)

(x) For variable-volume enclosures, unlatch the enclosure from the nominal volume configuration. For fixed-volume enclosures, open the outlet and inlet flow streams.

(xi) Start cycling the ambient temperature from 96 °F to 72 °F and back to 96 °F over a 24-hour period, according to the profile specified in § 86.1233-96 and appendix II of this part, within 15 minutes of sealing the enclosure.

(xii) At the completion of the 24-hour cycling period, analyze the enclosure atmosphere for hydrocarbon and methanol content; determine the net withdrawn methanol (in the case of diurnal emission testing with fixed-volume enclosures); record temperature and barometric pressure. These are the final readings for the hydrocarbon and methanol retention check. The final hydrocarbon and methanol mass, calculated in paragraph (d) of this section, shall be within 3 percent of that determined in paragraph (c)(1)(viii) of this section. (For calendar years through 1995, the difference may exceed  $\pm 3$  percent for methanol, provided it does not exceed  $\pm 6$  percent.)

(2) An enclosure to be used for the running loss test (see § 86.1234-96) shall meet the calibration and retention requirements of § 86.1217-90(c).

(3) Enclosures calibrated according to the procedures specified in either paragraph (c)(1) or (c)(2) of this section may be used for hot soak testing (see § 86.1238).

(4) The Administrator, upon request, may waive the requirement to comply with  $\pm 2$  percent methanol recovery tolerance, and/or the  $\pm 3$  percent retention tolerance and instead require compliance with higher tolerances (not to exceed  $\pm 6$  percent for recoveries and  $\pm 8$  for retention), provided that:

(i) The Administrator determines that compliance with these specified tolerances is not practically feasible; and

(ii) The manufacturer makes information available to the Administrator which indicates that the calibration tests and their results are consistent with good laboratory practice, and that the results

are consistent with the results of calibration testing conducted by the Administrator.

(d) *Calculations.* (1) The calculation of net methanol and hydrocarbon mass change is used to determine enclosure background and leak rate. It is also used to check the enclosure volume measurements. The methanol mass change is calculated from the initial and final methanol samples, the net withdrawn methanol (in the case of diurnal emission testing with fixed-volume enclosures), and initial and final temperature and pressure according to the following equation:

ER06OC93.120

Where:

(i)  $M_{CH_3OH}$ =Methanol mass change,  $\mu\text{g}$ .

(ii)  $V$ =Enclosure volume,  $\text{ft}^3$ , as measured in paragraph (b)(1) of this section.

(iii) [Reserved]

(iv) [Reserved]

(v)  $V_E$ =Volume of sample withdrawn,  $\text{ft}^3$ . Sample volumes must be corrected for differences in temperature to be consistent with determination of  $V_n$ , prior to being used in the equation.

(vi)  $P_B$ =Barometric pressure at time of sampling, in. Hg.

(vii)  $C_{MS}$ =GC concentration of test sample.

(viii)  $AV$ =Volume of absorbing reagent in impinger.

(ix)  $i$ =Initial sample.

(x)  $f$ =Final sample.

(xi)  $1$ =First impinger.

(xii)  $2$ =Second impinger.

(xiii)  $M_{CH_3OH,out}$ =mass of methanol exiting the enclosure, in the case of fixed-volume enclosures for diurnal emission testing,  $\mu\text{g}$ .

(xiv)  $M_{CH_3OH,in}$ =mass of methanol entering the enclosure, in the case of fixed-volume enclosures for diurnal emission testing,  $\mu\text{g}$ .

(2) The hydrocarbon mass change is calculated from the initial and final FID readings of hydrocarbon concentration, methanol concentration with FID response to methanol, temperature, and pressure according to the following equation:

ER06OC93.121

Where:

(i)  $M_{HC}$ =Hydrocarbon mass change, g.

(ii)  $C_{HC}$ =FID hydrocarbon concentration as ppm carbon including FID response to methanol in the sample.

(iii)  $C_{CH_3OH}$ =Methanol concentration as ppm carbon

ER06OC93.122

(iv)  $V$ =Enclosure volume  $\text{ft}^3$  ( $\text{m}^3$ ), as measured in paragraph (b)(1) of this section.

(v)  $r$ =FID response factor to methanol.

(vi)  $P_B$ =Barometric pressure, in. Hg. (kPa).

(vii)  $T$ =Enclosure ambient temperature, R(K) .

(viii)  $i$ =Indicates initial reading.

(ix)  $f$ =Indicates final reading.

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(x)(A)  $k=3.05$ .

(B) For SI units,  $k=17.60$ .

(xi)  $M_{HC,out}$ =mass of hydrocarbon exiting the enclosure, in the case of fixed-volume enclosures for diurnal emission testing, g.

(xii)  $M_{HC,in}$ =mass of hydrocarbon entering the enclosure, in the case of fixed-volume enclosures for diurnal emission testing, g.

(3) For variable-volume enclosures, defined in § 86.1207(a)(1)(i), the following simplified form of the hydrocarbon mass change equation may be used:

ER06OC93.123

(e) *Calibration of equipment for point-source testing of running losses.* For the point-source method, the running loss fuel vapor sampling system shall be calibrated as a CVS system, as specified in § 86.119, with the additional specification that the vapor sampling system verification be conducted as follows:

(1) The following "gravimetric" technique can be used to verify that the vapor sampling system and analytical instruments can accurately measure a mass of gas that has been injected into the system. If the vapor sampling system will be used only in the testing of petroleum-fueled engines, system verification may be performed using propane. If the vapor sampling system will be used with methanol-fueled vehicles as well as petroleum-fueled vehicles, the system verification performance check must include a methanol check in addition to the propane check. (Verification can also be accomplished by constant flow metering using critical flow orifice devices.)

(i) Obtain a small cylinder that has been charged with pure propane gas. Obtain another small cylinder that has been charged with pure methanol if the system will be used for methanol-fueled vehicle testing. Since this cylinder will be heated to 150–155 °F, care must be taken to ensure that the liquid volume of methanol placed in the cylinder does not exceed approximately one-half of the total volume of the cylinder.

(ii) Determine a reference cylinder weight to the nearest 0.01 grams.

(iii) Operate the vapor sampling system in the normal manner and release a known quantity of pure propane into the most frequently used fuel vapor collector during the sampling period (approximately 5 minutes).

(iv) Continue to operate the vapor sampling system in the normal manner and release a known quantity of pure methanol into the system during the sampling period (approximately 5 minutes).

(v) The calculations of § 86.1244 are performed in the normal way, except in the case of propane. The density of propane (17.30 g/ft<sup>3</sup>/carbon atom (0.6109 kg/m<sup>3</sup>/carbon atom)) is used in place of the density of exhaust hydrocarbons. In the case of

methanol, the density of 37.71 g/ft<sup>3</sup> (1.332 kg/m<sup>3</sup>) is used.

(vi) The gravimetric mass is subtracted from the vapor sampling system measured mass and then divided by the gravimetric mass to determine the percent accuracy of the system.

(vii) The cause for any discrepancy greater than  $\pm 2$  percent must be found and corrected.

(2) This procedure shall be conducted in the point-source running loss test environment with the collector installed in a vehicle in the normal test configuration. The fuel of the test vehicle shall either be diesel, or it shall be kept under 100 °F (38 °C). Two to six grams of pure propane and two to six grams of pure methanol shall be injected into the collector while the vehicle is operated over one Heavy-Duty Vehicle Urban Dynamometer Driving Schedule, as described in § 86.1215 and appendix I of this part. The propane and methanol injections shall be conducted at the ambient temperature of 95 $\pm$ 5 °F (35 $\pm$ 3 °C).

[58 FR 16050, Mar. 24, 1993, as amended at 60 FR 34360, June 30, 1995; 60 FR 43900, Aug. 23, 1995]

### § 86.1218-85 Dynamometer calibration.

(a) The dynamometer shall be calibrated at least once each month or performance verified at least once each week and then calibrated as required. The calibration shall consist of the manufacturer's recommended calibration procedure plus a determination of the dynamometer frictional power absorption. If the dynamometer is to be used for driving only the reference (transient) schedule, the frictional power absorption needs to be determined only at 50.0 mph (80.5 km/hr). If the dynamometer is to be used for driving the steady-state cycle, the frictional power absorption needs to be determined through the range of 15 to 50 mph. One method for determining dynamometer frictional power absorption at 50.0 mph (80.5 km/hr) is described below. The same general method can be used at other speeds. Other methods may be used if shown to yield equivalent results. The measured absorbed road power includes the dynamometer friction as well as the power absorbed by the power absorption unit. The dynamometer is driven above the test speed range. The device used to drive the dynamometer is then disengaged from the dynamometer and the roll(s) is (are) allowed to coastdown. The kinetic energy of the system is dissipated by the dynamometer. This method neglects the variations in roll bearing friction due to the drive axle weight of the vehicle. In the case of dynamometers with paired rolls, the inertia and power absorption of the free (rear) roll may be neglected if its inertia is less than 3.0 percent of the total equivalent inertia required for vehicle testing.

(1) Devise a method to determine the speed of the roll(s) to be measured for power absorption. A

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fifth wheel, revolution pickup, or other suitable means may be used.

(2) Place a vehicle on the dynamometer or devise another method of driving the dynamometer.

(3) If the dynamometer is capable of simulating more than a single inertia mass, engage the inertial flywheel or other inertial simulation system for the most common vehicle mass category for which the dynamometer is used. In addition, other vehicle mass categories may be calibrated, if desired.

(4) Drive the dynamometer up to 50 mph (80.5 km/hr).

(5) Record indicated road power.

(6) Drive the dynamometer up to 60 mph (96.9 km/hr).

(7) Disengage the device used to drive the dynamometer.

(8) Record the time for the dynamometer roll(s) to coastdown from 55.0 mph (88.5 km/hr) to 45.0 mph (72.4 km/hr).

(9) Adjust the power absorption unit to a different level.

(10) Repeat steps (4) to (8) above sufficient times to cover the range of road power used.

(11) Calculate absorbed road power ( $HP_d$ ). (See paragraph (c) of this section.)

(12) Plot indicated road load power at 50 mph (80.5 km/hr) versus road load power at 50 mph (80.5 km/hr).

(b) The performance check consists of conducting a dynamometer coastdown and comparing the coastdown time to that recorded during the last calibration. If the coastdown times differ by more than 1 second or by 5 percent of the time recorded during the last calibration, whichever is greater, a new calibration is required.

(c) Calculations. The road load power actually absorbed by each roll assembly (or roll-inertia weight assembly) of the dynamometer is calculated from the following equation:

$$HP_d = (1/2) (W/32.2) (V_1^2 - V_2^2) / 550t$$

Where:

$HP_d$  = Power, horsepower (kilowatts)

$W$  = Equivalent inertia, lb (kg)

$V_1$  = Initial velocity, ft/s (m/s) (55 mph = 88.5 km/h = 80.67 ft/s = 24.58 m/s)

$V_2$  = Final velocity, ft/s (m/s) (45 mph = 72.4 km/h = 66 ft/s = 20.11 m/s)

$t$  = Elapsed time for rolls to coast from 55 mph to 45 mph (88.5 to 72.4 km/hr).

(Expressions in parenthesis are for SI units). When the coastdown is from 55 to 45 mph (88.5 to 72.4 km/hr) the above equation reduces to:

$$HP_d = 0.06073 (W/t)$$

For SI units:

$$HP_d = 0.09984 (W/t)$$

The total road load power actually absorbed by the dynamometer is the sum of the absorbed road load power of each roll assembly.

## § 86.1221-90 Hydrocarbon analyzer calibration.

The FID hydrocarbon analyzer shall receive the following initial and periodic calibrations.

(a) *Initial and periodic optimization of detector response.* Prior to its introduction into service and at least annually thereafter, the FID hydrocarbon analyzer shall be adjusted for optimum hydrocarbon response. (The HFID used with methanol-fueled vehicles shall be operated at  $235^\circ \pm 15^\circ\text{F}$  ( $113^\circ \pm 8^\circ\text{C}$ )). Analyzers used with gasoline-fuel and liquefied petroleum gas-fuel shall be optimized using propane. Analyzers used with natural gas-fuel may be optimized using methane, or if calibrated using propane the FID response to methane shall be determined and applied to the FID hydrocarbon reading. Alternate methods yielding equivalent results may be used, if approved in advance by the Administrator.

(1) Follow the manufacturer's instructions or good engineering practice for instrument startup and basic operating adjustment using the appropriate FID fuel and zero-grade air.

(2) Optimize on the most common operating range. Introduce into the analyzer a propane (or methane as appropriate) in air mixture with a propane (or methane as appropriate) concentration equal to approximately 90 percent of the most common operating range.

(3) Select an operating FID fuel flow rate that will give near maximum response and least variation in response with minor fuel flow variations.

(4) To determine the optimum air flow, use the FID fuel flow setting determined above and vary air flow.

(5) After the optimum flow rates have been determined, record them for future reference.

(b) *Initial and periodic calibration.* Prior to its introduction into service and monthly thereafter the FID hydrocarbon analyzer shall be calibrated on all normally used instrument ranges, and, if applicable, the methanol response factor shall be determined (paragraph (c) of this section). Use the same flow rate as when analyzing sample.

(1) Adjust analyzer to optimize performance.

(2) Zero the hydrocarbon analyzer with zero-grade air.

(3) Calibrate on each normally used operating range with propane in air (or methane in air as appropriate) calibration gases having nominal concentrations of 15, 30, 45, 60, 75 and 90 percent of that range. For each range calibrated, if the deviation from a least squares best-fit straight line is two percent or less of the value at each data point, concentration values may be calculated by use of a single calibration factor for that range. If the deviation exceeds two percent at any point, the best-fit non-linear equation which represents the data to



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within two percent of each test point shall be used to determine concentration.

(c) *FID response factor to methanol.* When the FID analyzer is to be used for the analysis of hydrocarbon samples containing methanol, the methanol response factor of the analyzer shall be established. The methanol response factor shall be determined at several concentrations in the range of concentrations in the exhaust sample, using either bag samples or gas bottles meeting the requirements of § 86.114.

(1) The bag sample of methanol for analysis in the FID, if used, shall be prepared using the apparatus shown in Figure M90-1. A known volume of methanol is injected, using a microliter syringe, into the heated mixing zone (250°F (121°C) of the apparatus. The methanol is vaporized and swept into the sample bag with a known volume of zero grade air measured by a gas flow meter with an accuracy of  $\pm 2$  percent.

ER06OC93.184

(2) The bag sample is analyzed using the FID.

(3) The FID response factor,  $r$ , is calculated as follows:

$$r = \text{FID}_{\text{ppm}} / \text{SAM}_{\text{ppm}}$$

Where:

(i)  $r$  = FID response factor.

(ii)  $\text{FID}_{\text{ppm}}$  = FID reading in ppmC.

(iii)  $\text{SAM}_{\text{ppm}}$  = methanol concentration in the sample bag, or gas bottle, in ppmC.  $\text{SAM}_{\text{ppm}}$  for sample bags:

ER06OC93.124

Where:

(iv)  $0.02406$  = Volume of one mole at 29.92 in Hg and 68°F,  $\text{m}^3$ .

(v) Fuel injected = Volume of methanol injected, ml.

(vi) Fuel density = Density of methanol, 0.7914 g/ml.

(vii) Air volume = Volume of zero grade air,  $\text{m}^3$ .

(viii) Mol. Wt.  $\text{CH}_3\text{OH}$  = 32.04.

(d) The gas chromatograph used in the analysis of methanol samples shall be calibrated at least monthly following manufacturers' recommended procedures (certain equipment may require more frequent calibration based on use and good engineering judgment).

(e) *FID response factor to methane.* When the FID analyzer is to be used for the analysis of natural gas-fueled vehicle hydrocarbon samples has been calibrated using propane, the methane response factor of the analyzer shall be established. To determine the total hydrocarbon FID response to methane, known methane in air concentrations traceable to National Institute of Standards and Technology (NIST) shall be analyzed by the FID. Several methane concentrations shall be analyzed by the FID in the range of concentrations in the

exhaust sample. The total hydrocarbon FID response to methane is calculated as follows:

$$r_{\text{CH}_4} = \text{FID}_{\text{ppm}} / \text{SAM}_{\text{ppm}}$$

Where:

(1)  $r_{\text{CH}_4}$  = FID response factor to methane.

(2)  $\text{FID}_{\text{ppm}}$  = FID reading in ppmC.

(3)  $\text{SAM}_{\text{ppm}}$  = the known methane concentration in ppmC.

[54 FR 14566, Apr. 11, 1989, as amended at 59 FR 48523, Sept. 21, 1994; 60 FR 34361, June 30, 1995]

## § 86.1226-85 Calibration of other equipment.

Other test equipment used for testing shall be calibrated as often as required by the manufacturer or as necessary according to good practice.

## § 86.1227-90 Test procedures; overview.

(a) The overall test consists of prescribed sequences of fueling, parking, and operating conditions. Vehicles are tested only for evaporative emissions.

(b) The evaporative emission test (gasoline-fueled and methanol-fueled vehicles) is designed to determine hydrocarbon and/or methanol evaporative emissions as a consequence of diurnal temperature fluctuation, urban driving and hot soaks during engine-off periods. It is associated with a series of events representative of heavy-duty vehicle operation, which result in hydrocarbon and/or methanol vapor losses. The test procedure is designed to measure:

(1) Diurnal breathing losses resulting from daily temperature changes, measured by the enclosure technique;

(2) Running losses from suspected sources (if indicated by engineering analysis or vehicle inspection) resulting from a simulated trip on a chassis dynamometer, measured by carbon traps; and

(3) Hot soak losses which result when the vehicle is parked and the hot engine is turned off, measured by the enclosure technique.

(c) Background concentrations are measured for all species for which emissions measurements are made. For evaporative testing, this requires measuring initial concentrations. (When testing methanol-fueled vehicles, manufacturers may choose not to measure background concentrations of methanol, and then assume that the concentrations are zero during calculations.)

[54 FR 14568, Apr. 11, 1989, as amended at 60 FR 34363, June 30, 1995]

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### § 86.1227-96 Test procedures; overview.

(a) The overall test consists of prescribed sequences of fueling, parking, and operating conditions. Vehicles are tested only for evaporative emissions.

(b) The evaporative emission test (gasoline-fueled, natural gas-fueled, liquefied petroleum gas-fueled, and methanol-fueled vehicles) is designed to determine hydrocarbon and/or methanol evaporative emissions as a consequence of diurnal temperature fluctuation urban driving and hot soaks during engine-off periods. It is associated with a series of events representative of heavy-duty vehicle operation, which result in hydrocarbon and/or methanol vapor losses. The test procedure is designed to measure:

(1) Diurnal emissions resulting from daily temperature changes (as well as relatively constant resting losses), measured by the enclosure technique (see § 86.1233);

(2) Running losses resulting from a simulated trip on a chassis dynamometer, measured by the enclosure or point-source technique (see § 86.1234; this test is not required for gaseous-fueled vehicles); and

(3) Hot soak losses, which result when the vehicle is parked and the hot engine is turned off, measured by the enclosure technique (see § 86.1238).

(c) Background concentrations are measured for all species for which emissions measurements are made. For evaporative testing, this requires measuring initial concentrations. (When testing methanol-fueled vehicles, manufacturers may choose not to measure background concentrations of methanol, and then assume that the concentrations are zero during calculations.)

[58 FR 16052, Mar. 24, 1993, as amended at 59 FR 48523, Sept. 21, 1994; 60 FR 34363, June 30, 1995]

### § 86.1228-85 Transmissions.

(a) All test conditions, except as noted, shall be run in a manner representative of in-use operation, and where appropriate, according to the manufacturer's recommendation to the ultimate purchaser.

(b) Except for the first idle mode, idle modes less than one minute in length shall be run with automatic transmissions in "Drive" and the wheels braked; manual transmissions shall be in gear with the clutch disengaged, except first idle. The first idle mode and idle modes longer than one minute in length shall be run with automatic transmissions in "Neutral," and manual transmissions shall be in "Neutral" with the clutch engaged (clutch may be disengaged for engine start-up).

(c) The vehicle shall be driven with minimum accelerator pedal movement to maintain the desired operation.

(d) Accelerations shall be driven smoothly according to the manufacturer's recommendation to the ultimate purchaser. For manual transmissions, the operator shall accomplish each shift with minimum time. If the vehicle cannot accelerate at the specified rate, the vehicle shall be operated at maximum available power until the vehicle speed reaches the value prescribed for that time in the driving schedule.

(e) For those deceleration modes which decelerate to zero, manual transmission clutches shall be depressed when the speed drops below 15 mph (24.1 km/hr), when engine roughness is evident, or when engine stalling is imminent.

### § 86.1229-85 Dynamometer load determination and fuel temperature profile.

(a) Flywheels, electrical or other means of simulating inertia shall be used. The value of equivalent inertia weight shall be within 250 pounds of the loaded vehicle weight (LVW). Loaded vehicle weight is defined as follows:

(1) For test vehicles which have an actual weight less than  $0.5 \times (\text{GVWR})$ ,

$$\text{LVW} = 0.5 \times (\text{Gross Vehicle Weight Rating})$$

(2) For test vehicles which have an actual weight (As tested) greater than  $0.5 \times (\text{GVWR})$ ,

$$\text{LVW} = \text{Actual Weight of Test Vehicle,}$$

(b) *Power absorption unit adjustment.* (1) The power absorption unit shall be adjusted to reproduce road load power at 50 mph true speed. The indicated road load power setting shall take into account the dynamometer friction. The relationship between road load (absorbed) power and indicated road load power for a particular dynamometer shall be determined by the procedure outlined in § 86.1218-85 or other suitable means.

(2) The road load power used shall be determined from the following equation:

$$\text{RLP} = 0.67(\text{H} \cdot 0.75)\text{W} + 0.00125[\text{LVW} \cdot (\text{N} \times \text{DW})]$$

Where:

RLP = Road Load Power at 50 mph (horsepower).

H = Vehicle overall maximum height (feet).

W = Vehicle overall maximum width (feet).

LVW = Loaded vehicle weight (pounds).

DW = Vehicle weight supported by the dynamometer (pounds).

N = Number of dynamometer rolls supporting a tire.

or the manufacturer may determine the road load power by an alternate procedure (including coastdown). Such alternate procedures shall exhibit good engineering judgement and shall be subject to review upon request by the Administrator. For vehicles which the manufacturer chooses

es to certify by the optional light-duty truck certification provision (§ 86.082-1(b)), the evaporative emission test procedure (and standard) will be that specified by the light-duty truck regulations.

(c) [Reserved]

(d) *Fuel temperature profile*—(1) *General requirements.* (i) To be tested for running losses, as specified in § 86.1234, a vehicle must have a fuel temperature profile. The following procedure is used to generate the fuel temperature profile, which serves as a target for controlling fuel temperatures during the running loss test. This profile represents the fuel temperature change that occurs during on-road driving. If a vehicle has more than one fuel tank, a profile shall be established for each tank. Manufacturers may also simultaneously generate a profile for vapor temperatures.

(ii) If a manufacturer uses a vehicle model to develop a profile to represent multiple models, the vehicle model selected must have the greatest expected fuel temperature increase during driving of all those models it represents. Also, manufacturers must select test vehicles with any available vehicle options that increase fuel temperatures during driving (for example, any feature that limits underbody airflow).

(iii) Manufacturers may conduct testing to develop fuel temperature profiles in a laboratory setting, subject to approval by the Administrator. The laboratory facility should simulate outdoor testing to reproduce fuel and vapor temperature behavior over the specified driving schedule. The design of the laboratory facility should include consideration of any parameters that may affect fuel temperatures, such as solar loading, pavement heat, and relative wind velocities around and underneath the test vehicle. Indoor testing to develop the fuel temperature profiles must be conducted with little or no vehicle-specific adjustment of laboratory parameters. Manufacturers would need to maintain an ongoing demonstration of correlation between laboratory and outdoor measurement of fuel temperatures. Specifically, fuel temperatures and pressures from indoor driving should be at least as high as measured when driving outdoors according to the procedures described in this section.

(iv) Small-volume manufacturers, as defined in § 86.094-14(b)(1), may use an alternate method for generating fuel temperature profiles, subject to the approval of the Administrator.

(v) The Administrator may conduct testing to establish any vehicle's temperature profiles or to verify compliance with fuel tank pressure requirements.

(2) *Vehicle instrumentation.* (i) The vehicle must be equipped with temperature sensors and pressure transducers, as described in § 86.1207-96(e) and (f), and a driver's aid, which shall be

configured to provide the test driver with the desired vehicle speed vs. time trace and the actual vehicle speed.

(ii) A computer, data logger, or strip chart data recorder shall record the following parameters at a minimum during the test run:

(A) Desired speed;

(B) Actual speed;

(C) Instantaneous average liquid fuel temperature ( $T_{liq}$ ); and

(D) Vapor space pressure (the Administrator may omit measurement of fuel tank pressure).

(iii) The data recording system described in paragraph (d)(2)(ii) of this section shall be capable of resolving time to  $\pm 1$  s, capable of resolving temperature to  $\pm 2^\circ$  F, capable of resolving pressure to  $\pm 1.0$  inch of water, and capable of resolving speed to  $\pm 1$  mph. The temperature and pressure signals shall be recorded at intervals of up to 1 minute; speed signals shall be recorded at intervals of up to 1 second.

(3) *Ambient conditions.* The procedure shall be run under the following ambient conditions. Conditions should be representative of sunny summer days.

(i) Starting ambient temperature ( $T_{amb,o}$ ) shall be at least  $95^\circ$  F, steady or increasing (no more than  $2^\circ$  F drop) during the procedure. Ambient temperature shall be measured and recorded in regular intervals of at least once every 5 minutes. Measure ambient temperature with the following requirements (based on Federal Standard for Siting Meteorological Sensors at Airports, FCM-S4-1987). The sensors shall be mounted  $5\pm 1$  feet ( $1.5\pm 0.3$  meters) above ground level. The sensors shall be protected from radiation from the sun, sky, earth, and any other surrounding objects, but at the same time be adequately ventilated. The sensors shall be installed in such a position as to ensure that measurements are representative of the free air circulation in the locality and not influenced by artificial conditions such as large buildings, cooling towers, and expanses of concrete and tarmac. Keep any grass and vegetation within 100 feet (30 meters) of the sensor clipped to a height of about 10 inches (25 centimeters) or less.

(ii) Wind conditions shall be calm to light with maximum wind speed of 15 mph. In the case of temporary gusting, wind speeds between 15 and 25 mph may occur for up to 5 percent of the total driving time without invalidating the data collection. Wind speed shall be measured and recorded in regular intervals of at least once per minute. Measure wind speed with the following requirements (based on *Federal Standard for Siting Meteorological Sensors at Airports*, FCM-S4-1987). The site should be relatively level, but small gradual slopes are acceptable. The sensor shall be mounted 30 to 33 feet (9 to 10 meters) above the

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average ground height within a radius of 500 feet (150 meters). The sensor height shall not exceed 33 feet, except as necessary to be at least 15 feet (5 meters) above the height of any obstruction (e.g. vegetation, buildings, etc.) within a 500 foot (150 meter) radius. An object is considered to be an obstruction if the included lateral angle from the sensor to the ends of the object is 10 degrees or more.

(iii) Road surface temperature shall be at least 125° F throughout the driving period. Pavement temperature shall be measured and recorded in regular intervals of at least once per minute. The track temperature may be measured with an embedded sensor, a portable temperature probe, or an infrared pyrometer that can provide an accuracy of  $\pm 2^\circ$  F. Temperatures must be measured on a surface representative of the surface where the vehicle is driven.

(iv) Conditions shall be sunny or mostly sunny with a maximum cloud cover of 25 percent.

(v) Reported cloud cover, wind speed, and ambient temperature should be consistent with that reported by the nearest weather station; the Administrator may request justification of any discrepancy.

(4) *Profile determination procedure.* (i) Drain the fuel tank(s) and fill with test fuel to the "tank fuel volume" defined in § 86.082-2. The test fuel should meet the specifications of § 86.1213, except that fuel with a lower volatility may be used, subject to Administrator approval. Manufacturers using a lower volatility fuel must generate a vapor temperature profile for demonstrating compliance with the limit on fuel tank pressure during the running loss test (see § 86.1234-96).

(ii) The vehicle shall be moved to the location where the data is to be collected. It may be driven a maximum distance of 5 miles and may also be transported by other means. The vehicle shall be stabilized by one of the following methods:

(A) The vehicle shall be parked for a minimum of 12 hours in an open area on a surface that is representative of the test road, without any artificial heating or cooling of the fuel. The orientation of the front of the vehicle during parking (e.g., N, SW, etc.) shall be documented.

(B) The vehicle may be soaked in a temperature-controlled environment to stabilize fuel temperatures. Before starting the drive, the vehicle shall be stabilized with fuel temperatures  $95 \pm 3^\circ$  F for at least one hour. The fuel temperature may not exceed  $98^\circ$  F at any time before the beginning of the driving schedule, during which only whole-vehicle heating and cooling may be used to control fuel temperatures. If a manufacturer uses the provisions of paragraph (d)(7)(v) of this section to establish a lower initial fuel temperature for the running loss test, the fuel in the test vehicle may

not be stabilized at a temperature higher than the newly established initial fuel temperature.

(iii) Once the ambient conditions specified in paragraph (d)(3) of this section are met and the vehicle has been stabilized according to paragraph (d)(4)(ii) of this section, the vehicle's engine may be started. The vehicle's air conditioning system (if so equipped) shall be set to the "normal" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be set to operate in "automatic" temperature and fan modes with the system set at  $72^\circ$  F.

(iv) The vehicle may be operated at minimum throttle for a period up to 60 seconds prior to the start of the driving schedule, as necessary to move from the parking location onto the road surface. The driver's aid shall be started and the vehicle operated over the driving cycle specified in § 86.1234-96(b) with the transmission operated in the same manner as specified in § 86.128-79. The data recording system shall provide a record of the required parameters over the entire period of driving.

(5) *Records required.* In addition to the vehicle data recording, the following parameters shall be documented for the determination of the fuel temperature profile:

- (i) Date and time of vehicle fueling;
- (ii) Odometer reading at vehicle fueling;
- (iii) Date and time vehicle was parked, parking location and orientation;
- (iv) Odometer reading at parking;
- (v) Date and time engine was started;
- (vi) Time of initiation of first Heavy-Duty Vehicle UDDS;
- (vii) Time of completion of the driving cycle;
- (viii) Ambient temperatures throughout the period of driving ( $T_{amb}$ );
- (ix) Wind speed throughout the period of driving;
- (x) Track surface temperatures throughout the period of driving cycle ( $T_{sur}$ );
- (xi) Percent cloud cover during the period of driving; and
- (xii) Ambient temperature, wind speed, and percent cloud cover reported by the nearest weather station for the time corresponding most closely to the period of driving.

(6) *Fuel tank pressure.* Tank pressure shall not exceed 10 inches of water at any time during the temperature profile determination unless a pressurized system is used and the manufacturer demonstrates that vapor would not be vented to the atmosphere upon fuel cap removal.

(7) *Calculation of temperature profiles.* (i) The traces from the driving schedule shall be verified to meet the speed tolerance requirements of

§ 86.1215. The following conditions shall be verified:

- (A)  $T_{amb,i} \geq T_{amb,o} + 2^{\circ}\text{F}$ .

Where,

- (1) i=instantaneous measurement throughout the drive; and  
 (2) o=initial measurement at the start of the specified driving schedule.  
 (B)  $T_{amb,o} \geq 95^{\circ}\text{F}$ .  
 (C)  $T_{sur,i} \cdot T_{amb,i} \geq 30^{\circ}\text{F}$ .  
 (D)  $W_{max} \leq 15$  mph.

(ii) Failure to comply with any of these requirements shall result in invalidation of the data and require that the procedure be repeated, beginning with the fuel drain at paragraph (d)(4)(i) of this section.

(iii) If all these requirements are met, the following calculations shall be performed to determine a profile for liquid fuel temperatures and, if applicable, for vapor temperatures:  $T_{i,profile} = T_i - T_o$ .  
 Where:

- (A)  $T_{i,profile}$ =the series of temperatures that comprise the relative temperature profile.  
 (B)  $T_i$ =the series of observed liquid fuel or vapor temperatures during the drive.  
 (C)  $T_o$ =the liquid fuel or vapor temperature observed at the start of the specified driving schedule.

(iv) The relative temperature profile consists of the set of temperatures at each 1-minute interval. If temperatures are sampled more frequently than once per minute, the temperature data points may represent a rolling average of temperatures sampled for up to one-minute intervals. If multiple valid test runs are conducted for any model, then all the collected data shall be used to calculate a composite profile, based on the average temperatures at each point. The absolute temperature profile is determined by adding 95° F (35° C) to each point of the relative profile. Other methodologies for developing corrected liquid fuel and vapor space temperature profiles may be used if demonstrated to yield equivalent results and approved in advance by the Administrator.

(v) Manufacturers may use a lower initial fuel temperature for the running loss test, if approved in advance by the Administrator. To demonstrate the need for such an adjustment, manufacturers would be expected to determine the maximum fuel temperature experienced by a vehicle during an extended park or after driving one UDDS cycle when exposed to the ambient conditions described in paragraph (d)(3) of this section. To use this provision, manufacturers would have to show maximum fuel temperatures no greater than 92° F.

[48 FR 1456, Jan. 12, 1983, as amended at 48 FR 52210, Nov. 16, 1983; 58 FR 16053, Mar. 24, 1993; 60 FR 43901, Aug. 23, 1995]

**§ 86.1230-85 Test sequence; general requirements.**

The test sequence shown in Figure M85-1 show the steps encountered as the test vehicle undergoes the test procedure. Ambient temperature levels encountered by the test vehicle throughout the test sequence shall not be less than 68°F (20°C) nor more than 86°F (30°C). The vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution.

ER06OC93.185

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[48 FR 1456, Jan. 12, 1983, as amended at 48 FR 52210, Nov. 16, 1983]

**§ 86.1230-96 Test sequence; general requirements.**

(a)(1) *Gasoline- and methanol-fueled vehicles.* The test sequence shown in figure M96-1 of this section shows the steps encountered as the test vehicle undergoes the procedures subsequently described to determine conformity with the standards set forth. The full three-diurnal sequence depicted in figure M96-1 tests vehicles for all sources of evaporative emissions. The supplemental two-diurnal test sequence is designed to verify that vehicles sufficiently purge their evaporative canisters during the dynamometer run. Sections 86.1232-96, 86.1233-96 and 86.1238-96 describe the separate specifications of the supplemental two-diurnal test sequence.

(2) *Gaseous-fueled vehicles.* The test sequence shown in figure M96-1 of this section shows the steps encountered as the test vehicle undergoes the procedures subsequently described to determine conformity with the standards set forth, with the exception that the fuel drain and fill and pre-condition canister steps are not required for gaseous-fueled vehicles. In addition, the supplemental two-diurnal test and the running loss test are not required.

(b) The vehicle test for fuel spitback during fuel dispensing is conducted as a stand-alone test (see § 86.1246). This test is not required for gaseous-fueled vehicles.

(c) Ambient temperature levels encountered by the test vehicle shall be not less than 68 °F nor more than 86 °F, unless otherwise specified. If a different ambient temperature is specified for soaking the vehicle, the soak period may be interrupted once for up to 10 minutes to transport the vehicle from one soak area to another, provided the ambient temperature experienced by the vehicle is never below 68 °F. The temperatures monitored during testing must be representative of those experienced by the test vehicle.

(d) The vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution.

## § 86.1231-90

(e) If tests are invalidated after collection of emission data from previous test segments, the test may be repeated to collect only those data points needed to complete emission measurements. Compliance with emission standards may be determined by combining emission measurements from different test runs. If any emission measurements are repeated, the new measurements supersede previous values.

ER23AU95.009

[58 FR 16054, Mar. 24, 1993, as amended at 59 FR 48524, Sept. 21, 1994; 60 FR 43902, Aug. 23, 1995]

### § 86.1231-90 Vehicle preparation.

(a) Prepare the fuel tank(s) for recording the temperature of the prescribed test fuel at the approximate mid-volume of the fuel when the tank is 40 percent full.

(b) Provide additional fittings and adapters, as required, to accommodate a fuel drain at the lowest point possible in the tank(s) as installed on the vehicle.

(c)(1) Any vapor storage device which absorbs HC vapors and/or CH<sub>3</sub>OH vapors and subsequently releases them to the engine induction system during vehicle operation shall be subjected to a minimum of 30 load-purge cycles or the equivalent thereof (4,000 miles or more of actual in-use vehicle service accumulation shall be considered equivalent). One load-purge cycle shall be accomplished by conducting one of the following procedures:

(i) *Vehicle Procedure.* Park a fully-warm vehicle (a vehicle that has been driven for at least 15 minutes) for a time period of at least 3 hours. Fill the fuel tank(s) to the prescribed "tank fuel volume" with specified test fuel (§ 86.1213) at room temperature. Then drive the vehicle through at least one cycle of the HDV reference (transient) urban dynamometer driving schedule.

(ii) *Laboratory Procedure.* Flow vapors (gasoline or methanol, as appropriate) into a pre-purged vapor storage device until at least 10 percent of the input HC or CH<sub>3</sub>OH mass flow rate is passing through the device. Purge the device with a volume of air which is at least as great as, and which has a temperature no higher than that which would be drawn through the device if it were installed on the test vehicle and the vehicle was operated according to the HDV reference (transient) urban dynamometer driving schedule. The vapor flow rate, the method used to generate the vapors, the air flow rate, and the air temperature shall be recorded. If pre-blended gas is used, then the composition and characteristics of the gas shall be recorded.

(2) Ten load-purge cycles accumulated immediately prior to testing shall be conducted accord-

ing to the method in paragraph (c)(1)(i) of this section. The preceding 20 cycles (minimum) shall be conducted according to either of the methods in paragraph (c)(1) (i) or (ii) of this section.

[54 FR 14568, Apr. 11, 1989]

### § 86.1231-96 Vehicle preparation.

(a) For gasoline- and methanol-fueled vehicles prepare the fuel tank(s) for recording the temperature of the prescribed test fuel, as described in § 86.1207-96(e).

(b) Provide additional fittings and adapters, as required, to accommodate a fuel drain at the lowest point possible in the tank(s) as installed on the vehicle.

(c) For preconditioning that involves loading the evaporative emission canister(s) with butane, provide valving or other means as necessary to allow purging and loading of the canister(s).

(d) For vehicles to be tested for running loss emissions, prepare the fuel tank(s) for measuring and recording the temperature and pressure of the fuel tank as specified in § 86.1207-96 (e) and (f). Measurement of vapor temperature is optional during the running loss test. If vapor temperature is not measured, fuel tank pressure need not be measured.

(e) For vehicles to be tested for running loss emissions, prepare the exhaust system by sealing or plugging all detectable sources of exhaust gas leaks. The exhaust system shall be tested or inspected to ensure that detectable exhaust hydrocarbons are not emitted into the running loss enclosure during the running loss test.

[58 FR 16056, Mar. 24, 1993, as amended at 60 FR 43904, Aug. 23, 1995]

### § 86.1232-90 Vehicle preconditioning.

(a) The vehicle shall be moved to the test area and the following operations performed:

(1) The fuel tank(s) shall be drained through the provided fuel tank(s) drain(s) and filled to the prescribed "tank fuel volume" with the specified test fuel, § 86.1213. For the above operations the evaporative emission control system shall neither be abnormally purged nor abnormally loaded.

(2) Within one hour of being fueled the vehicle shall be placed, either by being driven or pushed, on a dynamometer and operated through one HDV urban dynamometer driving schedule (see § 86.1215). A test vehicle may not be used to set dynamometer horsepower.

(3) The Administrator may choose to conduct additional preconditioning to insure that the evaporative emissions control system is stabilized. The additional preconditioning shall consist of an initial one hour minimum soak and one, two or three driving cycles of the dynamometer driving sched-

ule, as described in paragraph (a)(2) of this section, each followed by a soak of at least one hour with engine off, engine compartment cover closed and cooling fan off. The vehicle may be driven off the dynamometer for the soak period which follows each driving cycle.

(b) After completion of preconditioning the vehicle shall be driven off the dynamometer and parked. The engine shall be turned off within five minutes of completion of preconditioning. The vehicle may be pushed to its parking location after its engine has been turned off.

[54 FR 14568, Apr. 11, 1989]

**§ 86.1232–96 Vehicle preconditioning.**

(a) Fuel tank cap(s) of gasoline- and methanol-fueled vehicles shall be removed during any period that the vehicle is parked outdoors awaiting testing, to prevent unusual loading of the canisters. During this time care must be taken to prevent entry of water or other contaminants into the fuel tank. During storage in the test area while awaiting testing, the fuel tank cap(s) may be in place. The vehicle shall be moved into the test area and the following operations performed.

(b)(1) *Gasoline- and methanol-fueled vehicles.* Drain the fuel tank(s) and fill with test fuel, as specified in § 86.1213, to the “tank fuel volume” defined in § 86.082–2. The fuel cap(s) shall be installed within one minute after refueling.

(2) *Gaseous-fueled vehicles.* Vehicle fuel tanks are to be filled with fuel that meets the specifications in § 86.113. Fuel tanks shall be filled to a minimum of 75% of service pressure for natural gas-fueled vehicles or a minimum of 75% of available fill volume for liquefied petroleum gas-fueled vehicles. Prior draining of the fuel tanks is not called for if the fuel in the tanks already meets the specifications in § 86.113.

(c) Gasoline- and methanol-fueled vehicles shall be soaked for at least 6 hours after being refueled. Gaseous-fueled vehicles shall be soaked for at least 1 hour after being refueled. Following this soak period, the test vehicle shall be placed, either by being driven or pushed, on a dynamometer and operated through one Heavy-Duty Vehicle Urban Dynamometer Driving schedule, specified in § 86.1215 and Appendix I of this part. Once a test vehicle has completed the refueling and vehicle soak steps specified in paragraphs (b) and (c) of this section, these steps may be omitted in subsequent testing with the same vehicle and the same fuel specifications, provided the vehicle remains under laboratory ambient temperature conditions for at least 6 hours before starting the next test. In such cases, each subsequent test shall begin with the preconditioning drive specified in this paragraph. The test vehicle may not be used to set dynamometer horsepower.

(d) [Reserved]

(e) The Administrator may choose to conduct additional preconditioning to ensure that the evaporative emissions control system is stabilized. The additional preconditioning shall consist of an initial one hour minimum soak and one, two or three driving cycles of the dynamometer driving schedule, as described in paragraph (c) of this section, each followed by a soak of at least one hour with engine off, engine compartment cover closed and cooling fan off. The vehicle may be driven off the dynamometer for the soak period that follows each driving cycle.

(f)(1) *Gasoline- and methanol-fueled vehicles.* After completion of the preconditioning drive, the vehicle shall be driven off the dynamometer. The vehicle’s fuel tank(s) shall be drained and then filled with test fuel, as specified in § 86.1213, to the “tank fuel volume” defined in § 86.082–2. The vehicle shall be refueled within 1 hour after completion of the preconditioning drive. The fuel cap(s) shall be installed within 1 minute after refueling. The vehicle shall be parked within five minutes after refueling.

(2) *Gaseous-fueled vehicles.* After completion of the preconditioning drive, the vehicle shall be driven off the dynamometer. Vehicle fuel tanks shall be refilled with fuel that meets the specifications in § 86.1213. Fuel tanks shall be filled to a minimum of 75% of service pressure for natural gas-fueled vehicles or a minimum of 75% of available fill volume for liquefied petroleum gas-fueled vehicles. Prior draining of the fuel tanks is not called for if the fuel in the tanks already meets the specifications in § 86.1213. The vehicle shall be parked within five minutes after refueling, or, in the absence of refueling, within five minutes after completion of the preconditioning drive.

(g) The vehicle shall be soaked for not less than 12 hours nor more than 36 hours between the end of the refueling event and the beginning of the cold start exhaust emission test.

(h) During the soak period for the three-diurnal test sequence described in § 86.1230–96, evaporative canisters, if the vehicle is so equipped, shall be preconditioned according to the following procedure. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister must be preconditioned separately. If production evaporative canisters are equipped with a functional service port designed for vapor load or purge steps, the service port shall be used during testing to precondition the canister. In addition, for model year 1998 and later vehicles equipped with refueling canisters, these canisters shall be preconditioned for the three-diurnal test sequence according to the procedure in paragraph (j)(1) of

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this section. If a vehicle is designed to actively control evaporative or refueling emissions without a canister, the manufacturer shall devise an appropriate preconditioning procedure, subject to the approval of the Administrator.

(1)(i) Prepare the evaporative emission canister for the canister purging and loading operation. The canister shall not be removed from the vehicle, unless access to the canister in its normal location is so restricted that purging and loading can only reasonably be accomplished by removing the canister from the vehicle. Special care shall be taken during this step to avoid damage to the components and the integrity of the fuel system. A replacement canister may be temporarily installed during the soak period while the canister from the test vehicle is preconditioned.

(ii) The canister purge shall be performed with ambient air of humidity controlled to  $50 \pm 25$  grains per pound of dry air. This may be accomplished by purging the canister in a room that is conditioned to this level of absolute humidity. The flow rate of the purge air shall be maintained at a nominal flow rate of 0.8 cfm and the duration shall be determined to provide a total purge volume flow through the canister equivalent to 300 canister bed volume exchanges. The bed volume is based on the volume of adsorbing material in the canister.

(iii) The evaporative emission canister shall then be loaded by sending to the canister an amount of commercial grade butane vapors equivalent to 1.5 times its nominal working capacity. The canister shall be loaded with a mixture composed of 50 percent butane and 50 percent nitrogen by volume at a rate of  $15 \pm 2$  grams butane per hour. If the canister loading at that rate takes longer than 12 hours, a manufacturer may determine a new rate, based on completing the canister loading in no less than 12 hours. The new rate may be used for all subsequent canister loading according to paragraph (h) of this section. The time of initiation and completion of the canister loading shall be recorded.

(iv) The determination of a canister's nominal working capacity shall be based on the average capacity of no less than five canisters that are in a stabilized condition.

(A) For stabilization, each canister must be loaded no less than 10 times and no more than 100 times to 2-gram breakthrough with a 50/50 mixture by volume of butane and nitrogen, at a rate of 15 grams butane per hour. Each canister loading step must be preceded by canister purging with 300 canister bed volume exchanges at 0.8 cfm.

(B) For determining working capacity, each canister must first be purged with 300 canister bed volume exchanges at 0.8 cfm. The working capac-

ity of each canister shall be established by determining the mass of butane required to load the canister from the purged state so that it emits 2 grams of hydrocarbon vapor; the canister must be loaded with a 50/50 mixture by volume of butane and nitrogen, at a rate of 15 grams butane per hour.

(2) For methanol-fueled and flexible-fueled vehicles, canister preconditioning shall be performed with a fuel vapor composition representative of that which the vehicle would generate with the fuel mixture used for the current test. Manufacturers shall develop a procedure to precondition the evaporative canister, if the vehicle is so equipped, for the different fuel. The procedure shall represent a canister loading equivalent to that specified in paragraph (h)(1) of this section and shall be approved in advance by the Administrator.

(i) [Reserved]

(j) For the supplemental two-diurnal test sequence described in § 86.1230-96, one of the following methods shall be used to precondition evaporative canisters during the soak period specified in paragraph (g) of this section. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister must be preconditioned separately. In addition, for model year 1998 and later vehicles equipped with refueling canisters, these canisters shall be preconditioned for the supplemental two-diurnal test sequence according to the procedure in paragraph (j)(1) of this section. Canister emissions are measured to determine breakthrough. Breakthrough is here defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams.

(1) *Butane loading to breakthrough.* The following procedure provides for emission measurement in an enclosure. Breakthrough may also be determined by measuring the weight gain of an auxiliary evaporative canister connected downstream of the vehicle's canister, in which case, the following references to the enclosure can be ignored. The auxiliary canister shall be well purged prior to loading. If production evaporative canisters are equipped with a functional service port designed for vapor load or purge steps, the service port shall be used during testing to precondition the canister.

(i) Prepare the evaporative/refueling emission canister for the canister loading operation. The canister shall not be removed from the vehicle, unless access to the canister in its normal location is so restricted that purging and loading can only reasonably be accomplished by removing the canister from the vehicle. Special care shall be taken during this step to avoid damage to the compo-



nents and the integrity of the fuel system. A replacement canister may be temporarily installed during the soak period while the canister from the test vehicle is preconditioned.

(ii) The evaporative emission enclosure shall be purged for several minutes. WARNING: If at any time the concentration of hydrocarbons, of methanol, or of methanol and hydrocarbons exceeds 15,000 ppm C the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

(iii) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the canister loading procedure.

(iv) If not already on, the evaporative enclosure mixing fan shall be turned on at this time.

(v) Place the vehicle in a sealed enclosure and measure emissions with a FID.

(vi)(A) For gasoline-fueled vehicles, load the canister with a mixture composed of 50 percent butane and 50 percent nitrogen by volume at a rate of 40 grams butane per hour.

(B) For methanol-fueled and flexible-fueled vehicles, canister preconditioning shall be performed with a fuel vapor composition representative of that which the vehicle would generate with the fuel mixture used for the current test. Manufacturers shall develop a procedure to precondition the evaporative canister, if the vehicle is so equipped, for the different fuel.

(vii) As soon as the canister reaches breakthrough, the vapor source shall be shut off.

(viii) Reconnect the evaporative emission canister and restore the vehicle to its normal operating condition.

(2) *Load with repeated diurnal heat builds to breakthrough.* The following procedure provides for emission measurement in an enclosure. Breakthrough may also be determined by measuring the weight gain of an auxiliary evaporative canister connected downstream of the vehicle's canister, in which case, the following references to the enclosure can be ignored. The auxiliary canister shall be well purged with dry air prior to loading.

(i) The evaporative emission enclosure shall be purged for several minutes. WARNING: If at any time the concentration of hydrocarbons, of methanol, or of methanol and hydrocarbons exceeds 15,000 ppm C the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

(ii) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the diurnal heat builds.

(iii) If not already on, the evaporative enclosure mixing fan shall be turned on at this time.

(iv) The fuel tank(s) of the prepared vehicle shall be drained and filled with test fuel, as specified in § 86.1213, to the "tank fuel volume" defined in § 86.082-2. The average temperature of the dispensed fuel shall be  $60 \pm 12$  °F ( $16 \pm 7$  °C). The fuel tank cap(s) shall be installed within 1 minute after refueling.

(v) Within one hour of being refueled, the vehicle shall be placed, with the engine shut off, in the evaporative emission enclosure. The fuel tank temperature sensor shall be connected to the temperature recording system. A heat source, specified in § 86.1207-90(d), shall be properly positioned with respect to the fuel tank(s) and connected to the temperature controller.

(vi) The temperature recording system shall be started.

(vii) The fuel may be artificially heated to the starting diurnal temperature.

(viii) When the fuel temperature reaches at least 69 °F (21 °C), immediately turn off purge blower (if not already off); close and seal enclosure doors; and initiate measurement of the hydrocarbon level in the enclosure.

(ix) When the fuel temperature reaches  $72 \pm 2$  °F ( $22 \pm 1$  °C), start the diurnal heat build.

(x) The fuel shall be heated in such a way that its temperature change conforms to the following function to within  $\pm 4$  °F ( $\pm 3$  °C):

$F = T_o + 0.4t$ ; or

for SI units,

$C = T_o + (2/9)t$ .

Where,

F=fuel temperature, °F;

C=fuel temperature, °C;

t=time since beginning of test, minutes; and

$T_o$ =initial temperature in °F (°C for SI units).

(xi) As soon as breakthrough occurs or when the fuel temperature reaches 96 °F (36 °C), whichever occurs first, the heat source shall be turned off, the enclosure doors shall be unsealed and opened, and the vehicle fuel tank cap(s) shall be removed. If breakthrough has not occurred by the time the fuel temperature reaches 96 °F (36 °C), the heat source shall be removed from the vehicle, the vehicle shall be removed (with engine still off) from the evaporative emission enclosure and the entire procedure outlined in paragraph (j)(2) of this section shall be repeated until breakthrough occurs.

(xii) After breakthrough occurs, the fuel tank(s) of the prepared vehicle shall be drained and filled with test fuel, as specified in § 86.1213, to the "tank fuel volume" defined in § 86.082-2. The fuel shall be stabilized to a temperature within 3 °F of the lab ambient before beginning the driving cycle for the dynamometer run.

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(k) The Administrator may conduct the vehicle preparation and preconditioning for measurement of fuel economy or exhaust emissions according to the procedures specified in §§ 86.1232-90 and 86.1233-90, in lieu of the procedures specified in this section.

(l) Vehicles to be tested for exhaust emissions only shall be processed according to §§ 86.1235 through 86.1237. Vehicles to be tested for evaporative emissions shall be processed in accordance with the procedures in §§ 86.1233 through 86.1238, starting with § 86.1235.

(m) Vehicles to be tested for evaporative emissions with the supplemental two-diurnal test sequence described in § 86.1230-96, shall proceed according to §§ 86.1235 through 86.1237, followed by the supplemental hot soak test (see § 86.1238-96(k)) and the supplemental diurnal emission test (see § 86.1233-96(p)).

[58 FR 16056, Mar. 24, 1993, as amended at 59 FR 48524, Sept. 21, 1994; 60 FR 43904, Aug. 23, 1995]

### § 86.1233-90 Diurnal breathing loss test.

(a) Following vehicle preparation and vehicle preconditioning procedures described in §§ 86.1231 and 86.1232, the diurnal test shall start not less than 10 or more than 35 hours after the end of the preconditioning procedure. The start of vehicle operation shall follow the end of the diurnal test within one hour.

(b) The evaporative emissions enclosure shall be purged for several minutes immediately prior to the test.

NOTE: If at any time the concentration of hydrocarbons, or of methanol, or of hydrocarbons and methanol exceeds 15,000 ppm C the enclosure should be immediately purged. This concentration provides a 4:1 safety factor against the lean flammability limit.

(c) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the test.

(d) Impingers charged with known volumes of pure deionized water shall be placed in the methanol sampling system (methanol-fueled vehicles only).

(e) If not already on, the evaporative enclosure mixing fan(s) shall be turned on at this time.

(f) For vehicles with multiple tanks, the largest tank shall be designated as the primary tank and shall be heated in accordance with the procedures described in paragraph (m) of this section. All other tanks shall be designated as auxiliary tanks and shall undergo a similar heat build such that the fuel temperature shall be within 3 °F (1.6 °C) of the primary tank.

(g) Immediately prior to the diurnal breathing loss test, the fuel tank(s) of the prepared vehicle shall be drained and recharged with the specified

test fuel as defined in § 86.1213 to the prescribed "tank fuel volume", as defined in § 86.078-2. The temperature of the fuel prior to its delivery to the fuel tank shall be between 45 °F and 60 °F (7.2 °C and 16 °C). The fuel tank cap(s) is not installed until the diurnal heat build begins.

(h) The test vehicle, with the engine shut off, shall be moved into the evaporative emission enclosure, the test vehicle windows and any storage compartments shall be opened, the fuel tank temperature sensor shall be connected to the temperature recording system, and, if required, the heat source shall be properly positioned with respect to the fuel tank(s) and/or connected to the temperature controller.

(i) The temperature recording system shall be started.

(j) The fuel may be artificially heated to the starting diurnal temperature, 60 °F±2 °F (16 °C±1.1 °C).

(k) When the fuel temperature recording system reaches at least 58 °F (14 °C), immediately:

(1) Install fuel tank cap(s).

(2) Turn off purge blowers, if not already off at this time.

(3) Close and seal enclosure doors.

(l) When the fuel temperature recording system reaches 60 °F±2 °F (16 °C±1.1 °C) immediately:

(1) Analyze enclosure atmosphere for hydrocarbons and record. This is the initial (time = 0 minutes) hydrocarbon concentration,  $CHC_i$  (see § 86.1243).

(2) Simultaneously with initiation of the hydrocarbon analysis, initiate collection of the methanol sample by drawing a sample from the enclosure through the sampling system for four minutes. This is the initial methanol measurement from which methanol concentration  $C_{CH_3OH_i}$  and mass are calculated. Remove impingers and replace with freshly charged clean impingers which will be used to collect the final methanol sample.

(3) Record barometric pressure reading. This is the initial (time = 0 minutes) barometric pressure,  $P_{bi}$  (see § 86.1243).

(4) Record enclosure ambient temperature. This is the initial (time = 0 minutes) enclosure ambient temperature,  $T_i$  (see § 86.1243).

(5) Start diurnal heat build and record time. This commences the 60±2 minute test period.

(m) The fuel shall be heated in such a way that its temperature change conforms to the following function to within ±3 °F (±1.6 °C):

$$(1) F = T_o + 0.4t$$

$$(2) \text{ For SI units, } C = T_o + (2/9)t$$

Where:

F = fuel temperature, °F.

C = fuel temperature, °C.

t = heating time, minutes.

$T_o$  = initial temperature in °F (or in °C for SI units).

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After 60±2 minutes of heating, the fuel temperature rise shall be 240±1 °F (13.30±0.5 °C).

(n) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of the diurnal test.

(o)(1) The end of the diurnal breathing loss test occurs 60±2 minutes after the heat build begins (paragraph (k)(4) of this section). Analyze the enclosure atmosphere for hydrocarbon and record. This is the final (time = 60 minutes) hydrocarbon concentration,  $C_{HCF}$  (see § 86.1234). The time (or elapsed time) of this analysis shall be recorded.

(2) Simultaneously with the start of the hydrocarbon analysis, initiate collection of the methanol sample. Sample for four minutes. This is the final methanol sample.

(3) *Alternate method for methanol sampling.* Since sample times of longer than four minutes may be necessary in order to collect an adequate and representative sample of methanol at the end of a test (when SHED concentrations are usually increasing rapidly), it may be necessary to rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flowing through the impingers should be minimized in order to prevent any losses. This alternative must be adopted if the four minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis.

(4) Record barometric pressure reading. This is the final (time = 60 minutes) barometric pressure,  $P_{bf}$  (see § 86.1243).

(5) Record enclosure ambient temperature. This is the final (time = 60 minutes) enclosure ambient temperature,  $T_f$  (see § 86.1243).

(p) The heat source shall be turned off and the enclosure doors unsealed.

(q) The heat source shall be moved away from the vehicle, if required, and/or disconnected from the temperature controller, the fuel tank temperature sensor shall be disconnected from the temperature recording system, and the test vehicle windows and any storage compartments may be closed. The vehicle shall be either driven or pushed out of the evaporative emission enclosure.

[54 FR 14568, Apr. 11, 1989]

### § 86.1233-96 Diurnal emission test.

(a)(1) The diurnal emission test for gasoline-, methanol- and gaseous-fueled vehicles consists of three 24-hour test cycles following the hot soak test. Emissions are measured for each 24-hour cycle, with the highest emission level used to determine compliance with the standards specified in subpart A of this part. The Administrator may truncate a test after any 24-hour cycle without affecting the validity of the collected data. Sampling

of emissions from the running loss and hot soak tests is not required as preparation for the diurnal emission test. The diurnal emission test may be conducted as part of either the three-diurnal test sequence or the supplemental two-diurnal test sequence, as described in § 86.1230-96.

(2) For the full three-diurnal test sequence, the diurnal emission test outlined in paragraphs (b) through (o) of this section follows the high-temperature hot soak test concluded in § 86.1238-96(j).

(3) For the supplemental two-diurnal test sequence, the diurnal emission test outlined in paragraph (p) of this section follows the alternate hot soak test specified in § 86.1238-96(k). This test is not required for gaseous-fueled vehicles.

(b) The test vehicle shall be soaked for not less than 6 hours nor more than 36 hours between the end of the hot soak test and the start of the diurnal emission test. For at least the last 6 hours of this period, the vehicle shall be soaked at 72±3 °F. The temperature tolerance may be waived for up to 10 minutes to allow purging of the enclosure or transporting the vehicle into the enclosure at the beginning of the diurnal emission test.

(c) The test vehicle shall be exposed to ambient temperatures cycled according to the profile specified in § 86.1233 and Appendix II of this part.

(1) Temperatures measured with the underbody temperature sensor shall follow the profile with a maximum deviation of 3° F at any time and an average temperature deviation not to exceed 2° F, where the average deviation is calculated using the absolute value of each measured deviation. In addition, the temperature from the sidewall temperature sensors shall follow the profile with a maximum deviation of 5° F at any time.

(2) Ambient temperatures shall be measured at least every minute. Temperature cycling shall begin when time=0 minutes, as specified in paragraph (i)(5) of this section.

(d) The diurnal enclosure shall be purged for several minutes prior to the test. WARNING: If at any time the concentration of hydrocarbons, of methanol or of methanol and hydrocarbons exceeds 15,000 ppm C the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

(e) The test vehicle, with the engine shut off and the test vehicle windows and luggage compartment(s) opened, shall be moved into the diurnal enclosure.

(f)-(g) [Reserved]

(h) Prior to sampling for emissions and throughout the period of cycled ambient temperatures, the mixing fan(s) shall circulate the air at a rate of 0.8±0.2 cfm per cubic foot of ambient volume. The mixing fan(s), plus any additional fans if

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needed, shall also maintain a minimum wind speed of 5 mph (8 km/hr) under the fuel tank of the test vehicle. The Administrator may adjust fan speed and location to ensure sufficient air circulation around the fuel tank. The wind speed requirement may be satisfied by consistently using a fan configuration that has been demonstrated to maintain a broad 5-mph air flow in the vicinity of the vehicle's fuel tank, subject to verification by the Administrator.

(i) Emission sampling may begin as follows:

(1) The FID (or HFID) hydrocarbon analyzer shall be zeroed and spanned immediately prior to the sampling.

(2) Impingers charged with known volumes of pure deionized water shall be placed in the methanol sampling system (methanol-fueled vehicles only).

(3) Turn off purge blowers (if not already off).

(4) Close and seal enclosure doors (if not already closed and sealed).

(5) Within 10 minutes of closing and sealing the doors, analyze enclosure atmosphere for hydrocarbons and record. This is the initial (time=0 minutes) hydrocarbon concentration,  $C_{HCi}$ , required in § 86.1243. Hydrocarbon emissions may be sampled continuously during the test period.

(6) Analyze the enclosure atmosphere for methanol, if applicable, and record. The methanol sampling must start simultaneously with the initiation of the hydrocarbon analysis and continue for  $4.0 \pm 0.5$  minutes. This is the initial methanol concentration,  $C_{CH_3OH_i}$ , required in § 86.1243. Record the time elapsed during this analysis. If the 4-minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flow through the impingers should be minimized to prevent any losses. If the test is conducted in a fixed-volume enclosure that allows airflow into and out of the enclosure, the effect of makeup air dilution must be factored into the analysis.

(j) If testing indicates that a vehicle design may result in fuel temperature responses during enclosure testing that are not representative of in-use summertime conditions, the Administrator may adjust air circulation and temperature during the test as needed to ensure that the test sufficiently duplicates the vehicle's in-use experience.

(k) The FID (or HFID) hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of each emission sampling period.

(l) Fresh impingers shall be installed in the methanol collection system immediately prior to

the end of each emission measurement, if applicable.

(m) The end of the first, second, and third emission sampling period shall occur  $1440 \pm 6$ ,  $2880 \pm 6$ ,  $4320 \pm 6$  minutes, respectively, after the beginning of the initial sampling, as specified in paragraph (i)(5) of this section.

(1) At the end of each emission sampling period, analyze the enclosure atmosphere for hydrocarbons and record. This is the final hydrocarbon concentration,  $C_{HCf}$ , required in § 86.1243. The emission measurement at the end of each period becomes the initial hydrocarbon concentration,  $C_{HCi}$ , of the next emission sampling period.

(2) Analyze the enclosure atmosphere for methanol, if applicable, and record. The methanol sampling must start simultaneously with the initiation of the hydrocarbon analysis and continue for  $4.0 \pm 0.5$  minutes. This is the final (time=1440 minutes) methanol concentration,  $C_{CH_3OHf}$ , required in § 86.1243. Record the time elapsed during this analysis. If the 4-minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flow through the impingers should be minimized to prevent any losses. If the test is conducted in a fixed-volume enclosure that allows airflow into and out of the enclosure, the effect of makeup air dilution must be factored into the analysis.

(n) At the end of the temperature cycling period the enclosure doors shall be unsealed and opened, the test vehicle windows and luggage compartments may be closed and the test vehicle, with the engine shut off, shall be removed from the enclosure.

(o) This completes the full three-diurnal evaporative emission test sequence described in § 86.1230-96.

(p) For the supplemental two-diurnal test sequence described in § 86.1230-96, the following steps shall be performed in lieu of the steps described in paragraphs (b) through (n) of this section.

(1) For the supplemental two-diurnal test sequence, the test vehicle shall be soaked for not less than 6 hours nor more than 36 hours between the end of the hot soak test described in § 86.1238-96(k), and the start of the two-diurnal emission test. For at least the last 6 hours of this period, the vehicle shall be soaked at  $72 \pm 3$  °F.

(2) The vehicle shall be tested for diurnal emissions according to the procedures specified in paragraphs (c) through (n) of this section, except that the test includes only two 24-hour periods. Therefore the end of the first and second emission

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sampling periods shall occur  $1440 \pm 6$  and  $2880 \pm 6$  minutes, respectively, after the initial sampling.

(3) This completes the supplemental two-diurnal test sequence for evaporative emission measurement.

[58 FR 16057, Mar. 24, 1993; 59 FR 48524, Sept. 21, 1994, as amended at 60 FR 43905, Aug. 23, 1995]

### § 86.1234–96 Running loss test.

(a) *Overview.* Gasoline- and methanol-fueled vehicles are to be tested for running loss emissions during simulated high-temperature urban driving; this test is not required for gaseous-fueled vehicles. During operation, tank temperatures are controlled according to a prescribed profile to simulate in-use conditions. If the vehicle is determined to have exceeded the standard before the end of the running loss test, the test may be terminated without invalidating the data. The test can be run either in a sealed enclosure or with the point-source method, as specified in paragraph (g) of this section. Measurement of vapor temperature is optional during the running loss test; however, if testing by the Administrator shows that a vehicle has exceeded an emission standard without measurement of vapor temperatures, the manufacturer may, utilizing its own resources, conduct subsequent testing on that vehicle to determine if the exceedance is attributable to inadequate control of vapor temperatures.

(b) *Driving schedule.* Conduct the running loss test by operating the test vehicle through three Heavy-Duty Vehicle Urban Dynamometer Driving Schedules (see § 86.1215 and appendix I of this part). Fifteen seconds after the engine starts, place the transmission in gear. Twenty seconds after the engine starts, begin the initial vehicle acceleration of the driving schedule. The transmission shall be operated according to the specifications of § 86.1228 during the driving cycles.

(c) *Dynamometer operation.* (1) The exhaust from the vehicle must be routed outside the test cell or enclosure. Exhaust gases may, but need not, be collected and sampled.

(2) Provisions of § 86.1235–85(c) shall apply.

(3) Practice runs over the prescribed driving schedule may not be performed at test point.

(4) Provisions of § 86.1235–85 (e) and (f) shall apply.

(5) If the dynamometer horsepower must be adjusted manually, it shall be set within 1 hour prior to the running loss test phase. The test vehicle shall not be used to make this adjustment. Dynamometers using automatic control of preselectable power settings may be set any time prior to the beginning of the emissions test.

(6) Dynamometer roll or shaft revolutions shall be used to determine the actual driving distance for the running loss test,  $D_{RL}$ , required in

§ 86.1243. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

(7) Provisions of § 86.1235–85(i) shall apply.

(8) The test run may be stopped if a warning light or gauge indicates that the vehicle's engine coolant has overheated.

(d) *Engine starting and restarting.* (1) Provisions of § 86.1236–85(a) shall apply.

(2) If the vehicle does not start after the manufacturer's recommended cranking time (or 10 continuous seconds in the absence of a manufacturer's recommendation), cranking shall cease for the period recommended by the manufacturer (or 10 seconds in the absence of a manufacturer's recommendation). This may be repeated for up to three start attempts. If the vehicle does not start after three attempts, the reason for failure to start shall be determined. If failure to start is an operational error, the vehicle shall be rescheduled for testing, starting with the soak period immediately preceding the running loss test.

(3) If failure to start is caused by a vehicle malfunction, corrective action of less than 30 minutes duration may be taken (according to § 86.090–25), and the test continued, provided that the ambient conditions to which the vehicle is exposed are maintained at  $95 \pm 5$  °F ( $35 \pm 3$  °C). When the engine starts, the timing sequence of the driving schedule shall begin. If failure to start is caused by vehicle malfunction and the vehicle cannot be started, the test shall be voided, the vehicle removed from the dynamometer, and corrective action may be taken according to § 86.090–25. The reason for the malfunction (if determined) and the corrective action taken shall be reported to the Administrator.

(4) Provisions of § 86.1236–85(b) shall apply.

(e) *Pressure checks.* No pressure checks of the evaporative system shall be allowed. Under no circumstances will any changes/repairs to the evaporative emissions control system be allowed.

(f) *Temperature stabilization.* Immediately after the hot transient exhaust emission test, the vehicle shall be soaked in a temperature controlled area for a maximum of 6 hours until the fuel temperature is stabilized. The fuel may be heated or cooled to stabilize fuel temperatures, but the fuel heating rate must not exceed 5° F in any 1-hour interval during the soak period. A manufacturer may use a faster heating rate or a longer period for stabilizing fuel temperatures if the needed heating cannot be easily accomplished in the 6-hour period, subject to Administrator approval.

(1) Fuel temperatures must be held at  $95 \pm 3$ ° F for at least one hour before the start of the running loss test.

(2) If a vehicle's fuel temperature profile has an initial temperature lower than 95° F, as described

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in § 86.1229-85(d)(7)(v), the fuel in the test vehicle must be stabilized to within 3° F of that temperature for at least one hour before the start of the running loss test.

(g) *Running loss test.* The running loss test may be conducted either by the enclosure method, or by the point-source method.

(1) *Enclosure method.* (i) The running loss enclosure shall be purged for several minutes immediately prior to the test. WARNING: If at any time the concentration of hydrocarbons, of methanol, or of methanol and hydrocarbons exceeds 15,000 ppm C the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

(ii) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the test.

(iii) If not already on, the running loss enclosure mixing fan(s) shall be turned on at this time. Throughout the test, the mixing fan(s) shall circulate the air at a rate of at least 1.0 cfm per cubic foot of ambient volume.

(iv) The test vehicle, with the engine off, shall be moved onto the dynamometer in the running loss enclosure. The vehicle engine compartment cover shall be unlatched, but closed as much as possible, allowing for the air intake equipment specified in paragraph (g)(1)(vii) of this section. The vehicle engine compartment cover may be closed if alternate routing is found for the air intake equipment. Any windows, doors, and luggage compartments shall be closed. A window may be opened to direct cooling air into the passenger compartment of the vehicle, if the vehicle is not equipped with its own air conditioning.

(v) Fans shall be positioned as described in §§ 86.1207-96 (d) and (h).

(vi) The vehicle air conditioning system (if so equipped) shall be set to the "normal" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be set to operate in "automatic" temperature and fan modes with the system set at 72 °F.

(vii) Connect the air intake equipment to the vehicle, if applicable. This connection shall be made to minimize leakage.

(viii) The temperature and pressure recording systems shall be started. Measurement of vapor temperature is optional during the running loss test. If vapor temperature is not measured, fuel tank pressure need not be measured.

(ix) Turn off purge blowers (if not already off).

(x) The temperature of the liquid fuel shall be monitored and recorded at least every 15 seconds with the temperature recording system specified in § 86.1207-96(e).

(xi) Close and seal the enclosure doors.

(xii) When the ambient temperature is 95±5° F (35±3° C) and the fuel has been stabilized according to paragraph (f) of this section, the running loss test may begin. Measure the initial ambient temperature and pressure.

(A) Analyze enclosure atmosphere for hydrocarbons and record. This is the initial (time=0 minutes) hydrocarbon concentration,  $C_{HCl}$ , required in § 86.1243. Hydrocarbon emissions may be sampled continuously during the test period.

(B) Analyze the enclosure atmosphere for methanol, if applicable, and record. The methanol sampling must start simultaneously with the initiation of the hydrocarbon analysis and continue for 4.0±0.5 minutes. This is the initial (time=0 minutes) methanol concentration,  $C_{CH_3OH}$ , required in § 86.1243. Record the time elapsed during this analysis. If the 4-minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flow through the impingers should be minimized to prevent any losses.

(xiii) Start the engine and begin operation of the vehicle over the drive cycle specified in paragraph (b) of this section.

(xiv) The ambient temperature shall be maintained at 95±5° F (95±2° F on average) during the running loss test, measured at the inlet to the cooling fan in front of the vehicle; it shall be recorded at least every 60 seconds.

(xv) The fuel temperature during the dynamometer drive shall be controlled to match the fuel tank temperature profile determined in § 86.1229. Measured fuel temperatures must be within ±3° F of the target profile throughout the test run. Vapor temperatures, if measured, must be within ±5° F of the target profile during the first 4186 seconds of the running loss test, and within ±3° F for the remaining 120 seconds of the test run. For any vehicle complying with the test standards, vapor temperatures may be higher than the specified tolerances without invalidating test results. For testing by the Administrator, vapor temperatures may be lower than the specified tolerances without invalidating test results. If the test vehicle has more than one fuel tank, the temperatures for both fuel tanks shall follow the target profiles determined in § 86.1229. The control system shall be tuned and operated to provide smooth and continuous tank temperature profiles that are representative of the on-road profiles.

(xvi) Tank pressure shall not exceed 10 inches of water at any time during the running loss test unless a pressurized system is used and the manufacturer demonstrates that vapor would not be vented to the atmosphere upon fuel cap removal.

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A vehicle may exceed the pressure limit for temporary periods during the running loss test, up to 10 percent of the total driving time, provided that the vehicle has demonstrated conformance with the pressure limit during the entire outdoor driving period specified in § 86.1229. Measurement of fuel tank pressures will be considered valid only if vapor temperatures are measured and controlled to the tolerances specified in paragraph (g)(1)(xv) of this section.

(xvii) The FID (or HFID) hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of the test.

(xviii) Fresh impingers shall be installed in the methanol collection system immediately prior to the end of the test, if applicable.

(xix) The running loss test ends with the completion of the third 2-minute idle period.

(xx) At the end of the running loss test:

(A) Analyze the enclosure atmosphere for hydrocarbons and record. This is the final hydrocarbon concentration,  $C_{HCF}$ , required in § 86.1243.

(B) Analyze the enclosure atmosphere for methanol, if applicable, and record. The methanol sampling must start prior to the end of the test and continue for  $4.0 \pm 0.5$  minutes. The methanol sampling must be completed within 2 minutes after the end of the running loss test. This is the final methanol concentration,  $C_{CH_3OH}$ , required in § 86.1243. Record the time elapsed during this analysis. If the 4-minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flow through the impingers should be minimized to prevent any losses.

(C) Turn off all the fans specified in § 86.1207–96(d). Also, the time that the vehicle's engine compartment cover is open for removal of air intake equipment, if applicable, shall be minimized to avoid loss of heat from the engine compartment.

(xxi) Turn off any CVS apparatus (if not already turned off).

(2) *Point-source method.* (i) The test vehicle, with the engine off, shall be moved onto the dynamometer. The vehicle engine compartment cover and any windows, doors, and luggage compartments shall be closed.

(ii) Fans shall be positioned as described in §§ 86.1235–85(b) and 86.1207–96(d).

(iii) The running loss vapor vent collection system shall be properly positioned at the potential fuel vapor vents or leaks of the vehicle's fuel system. Typical vapor vents for current fuel systems are the ports of the evaporative emission canister

and the pressure relief vent of the fuel tank (typically integrated into the fuel tank cap).

(iv) The running loss vapor vent collection system may be connected to a PDP-CVS or CFV-CVS bag collection system. Otherwise, running loss vapors shall be sampled continuously with analyzers meeting the requirements of § 86.1207–96(b).

(v) Fans shall be positioned as described in § 86.1207–96(d).

(vi) The vehicle air conditioning system (if so equipped) shall be set to the "normal" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be set to operate in "automatic" temperature and fan modes with the system set at 72 °F.

(vii) The temperature and pressure recording systems shall be started. Measurement of vapor temperature is optional during the running loss test. If vapor temperature is not measured, fuel tank pressure need not be measured.

(viii) The temperature of the liquid fuel shall be monitored and recorded at least every 15 seconds with the temperature recording system specified in § 86.1207–96(e).

(ix) When the ambient temperature is  $95 \pm 5$  °F ( $35 \pm 3$  °C) and the fuel tank temperature is  $95 \pm 3$  °F the running loss test may begin.

(x) The ambient temperature shall be maintained at  $95 \pm 5$  °F ( $95 \pm 2$  °F on average) during the running loss test, measured at the inlet to the cooling fan in front of the vehicle; it shall be recorded at least every 60 seconds.

(xi) Fuel temperatures shall be controlled according to the specifications of paragraph (g)(1)(xv) of this section.

(xii) The tank pressure requirements described in paragraph (g)(1)(xvi) of this section apply also to running loss testing by the point source method.

(xiii) The running loss test ends with completion of the third 2-minute idle period.

(xiv) If emissions are collected in bags, the sample bags must be analyzed within 20 minutes of their respective sample collection phases, as described in § 86.137–94(b)(15). The results of the analysis are used in § 86.1243 to calculate the mass of hydrocarbons emitted.

(xv) At the end of the running loss test, turn off all the fans specified in § 86.1207–96(d).

(h) Following the completion of the running loss drive, the vehicle may be tested for hot soak emissions as specified in § 86.1238–96.

[58 FR 16059, Mar. 24, 1993, as amended at 59 FR 48524, Sept. 21, 1994; 60 FR 43905, Aug. 23, 1995]

## § 86.1235-85

### § 86.1235-85 Dynamometer procedure.

(a) The dynamometer run consists of one HDV urban dynamometer driving schedule cycle starting within one hour after completion of the diurnal loss test. This run includes engine startup (with all accessories turned off) and operation over the driving schedule.

(b) During dynamometer operation, one or more cooling fans shall be positioned so as to direct cooling air to the vehicle in an appropriate manner. The engine compartment cover shall be closed. If, however, the manufacturer can show that the engine compartment cover must be open to provide a test representative of field operation, the Administrator will allow the engine cover to be open. In the case of vehicles with front engine compartments, the fan(s) shall be squarely positioned within 12 inches of the vehicle. In the case of vehicles with rear engine compartments (or if special designs make the above impractical), the cooling fan(s) shall be placed in a position to provide sufficient air to maintain vehicle cooling. The fan capacity shall normally not exceed 10,600 (cfm (5.0 m<sup>3</sup>/s)). If, however, the manufacturer can show that during field operation the vehicle receives additional cooling, and that such additional cooling is needed to provide a representative test, the fan capacity may be increased or additional fans used.

(c) The vehicle speed as measured from the dynamometer rolls shall be used.

(d) Practice runs over the prescribed driving schedule may be performed at test points, provided emissions are not measured, for the purpose of finding the minimum throttle action to maintain the proper speed-time relationship, or to permit test procedure adjustments.

NOTE: When using two-roll dynamometers a truer speed-time trace may be obtained by minimizing the rocking of the vehicle in the rolls. The rocking of the vehicle changes the tire rolling radius on each roll. This rocking may be minimized by restraining the vehicle horizontally (or nearly so) by using a cable and winch, or chain.

(e) Drive wheel tires shall be inflated to the maximum gauge pressure recommended to the ultimate purchaser. If drive wheel tires have a maximum recommended inflation gauge pressure of less than 45 psi (310 kPa), they may be inflated up to a gauge pressure of 45 psi (310 kPa) in order to prevent tire damage. The drive wheel tire pressure shall be recorded with the test results.

(f) If the dynamometer has not been operated during the 2-hour period immediately preceding the test it shall be warmed up for 15 minutes by operating at 30 mph (48 km/h) using a non-test vehicle or as recommended by the dynamometer manufacturer.

(g) If the dynamometer horsepower must be adjusted manually, the power shall be set within 1 hour prior to dynamometer operation preceding the hot soak test. The test vehicle shall not be used to make the adjustment.

(h) If the dynamometer horsepower is selected by automatic control, the power may be set anytime prior to the beginning of the driving cycle.

(i) Multiple drive axle vehicles will be tested in one axle drive mode of operation. Full time multiple drive axle vehicles will have all but one axle temporarily disengaged by the vehicle manufacturer. Multiple drive axle vehicles which can be manually shifted to a one axle drive mode will be tested in the one axle drive mode of operation, unless this would pose a safety hazard, in which case all but one axle will be temporarily disengaged by the vehicle manufacturer.

### § 86.1235-96 Dynamometer procedure.

Section 86.1235-96 includes text that specifies requirements that differ from § 86.1235-85. Where a paragraph in § 86.1235-85 is identical and applicable to § 86.1235-96, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see § 86.1235-85."

(a) The dynamometer run consists of one HDV urban dynamometer driving schedule cycle starting not less than 12 nor more than 36 hours after completion of the drive specified in § 86.1232-96. This run includes engine startup (with all accessories turned off) and operation over the driving schedule.

(b) through (i) [Reserved]. For guidance see § 86.1235-85.

[58 FR 16060, Mar. 24, 1993]

### § 86.1236-85 Engine starting and re-starting.

(a) *Starting.* (1) The engine shall be started (including choke operation) according to the manufacturers recommended starting procedures in the owner's manual. The initial idle period shall begin when the engine starts.

(2) The operator may use the choke, accelerator pedal, etc., where necessary to keep the engine running.

(3) If the manufacturer's operating instructions in the owner's manual do not specify a warm engine starting procedure, the engine shall be started by depressing the accelerator pedal about half way and cranking the engine until it starts.

(4) If the vehicle does not start after the manufacturer's recommended cranking time (or 10 continuous seconds in the absence of a manufacturer's recommendation), cranking shall cease for the period recommended by the manufacturer (or 10 seconds in the absence of a manufacturer's rec-



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ommendation). This may be repeated for up to three start attempts. If the vehicle does not start after three attempts, the reason for failure to start shall be determined. If failure to start is an operational error, the vehicle shall be rescheduled for the dynamometer run. If failure to start is caused by a vehicle malfunction, corrective action of less than 30 minutes duration may be taken, and the test continued. When the engine starts, the driving schedule timing sequence shall begin. If failure to start is caused by vehicle malfunction and the vehicle cannot be started, the test shall be voided, the vehicle removed from the dynamometer, and corrective action may be taken. The reasons for the malfunction (if determined) and the corrective action taken shall be recorded.

(b) *Stalling.* (1) If the engine stalls during an idle period, the engine shall be restarted immediately and the driving schedule continued. If the engine cannot be started soon enough to allow the vehicle to follow the next acceleration as prescribed, the driving schedule indicator shall be stopped. When the vehicle restarts, the driving schedule indicator shall be reactivated.

(2) If the engine stalls during some operating mode other than idle, the driving schedule indicator shall be stopped, the vehicle shall then be restarted and accelerated to the speed required at that point in the driving schedule and the driving schedule continued. During acceleration to this point, shifting shall be performed in accordance with § 86.1228-85.

(3) If the vehicle will not restart within one minute, the test shall be voided, the vehicle removed from the dynamometer, corrective action taken, and the vehicle rescheduled for testing. The reason for the malfunction (if determined) and the corrective action taken shall be recorded.

[48 FR 1456, Jan. 12, 1983, as amended at 58 FR 16060, Mar. 24, 1993]

### § 86.1237-85 Dynamometer runs.

(a) The vehicle shall be either driven or pushed onto the dynamometer; however, if driven, the period of engine operation between the end of the diurnal loss test and beginning of the hot soak preparation run shall not exceed 3 minutes, and the vehicle shall be driven at minimum throttle. The dynamometer run shall follow the diurnal heat build by not more than one hour. The vehicle shall be stored prior to dynamometer operation in such a manner that it is not exposed to precipitation (e.g., rain or dew).

(b) The following steps shall be taken for the dynamometer run:

(1) Place drive wheels of vehicle on the dynamometer.

(2) Position the cooling fan(s).

(3) Attach an exhaust tube to the vehicle tailpipe(s).

(4) Start the engine.

(5) Turn on the cooling fan(s).

(6) Operate the vehicle according to the dynamometer driving schedule (§ 86.1215-85).

(7) At the end of the last deceleration, disconnect the exhaust tube from the vehicle tailpipe(s) and drive vehicle from the dynamometer.

### § 86.1237-96 Dynamometer runs.

Section 86.1237-96 includes text that specifies requirements that differ from § 86.1237-85. Where a paragraph in § 86.1237-85 is identical and applicable to § 86.1237-96, this may be indicated by specifying the corresponding paragraph and the statement “[Reserved]. For guidance see § 86.1237-85.”

(a) The vehicle shall be either driven or pushed onto the dynamometer; however, if driven, the total time of engine operation during the 12 to 36 hour soak period shall not exceed 3 minutes, and the vehicle shall be driven at minimum throttle. The vehicle shall be stored prior to dynamometer operation in such a manner that it is not exposed to precipitation (e.g., rain or dew).

(b) [Reserved]. For guidance see § 86.1235-85.

[58 FR 16061, Mar. 24, 1993]

### § 86.1238-90 Hot soak test.

The one-hour hot-soak evaporative emission test shall be conducted immediately following one cycle of the dynamometer driving schedule.

(a) Prior to the completion of the dynamometer cycle, the evaporative emission enclosure shall be purged for several minutes.

(b) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the test.

(c) Fresh impingers shall be installed in the methanol sample collection system immediately prior to the start of the test, if applicable.

(d) If not already on, the evaporative enclosure mixing fan(s) shall be turned on at this time.

(e) Upon completion of the dynamometer run the exhaust tube shall be disconnected from the vehicle tailpipe(s), the cooling fan(s) shall be moved, and the vehicle shall be disconnected from the dynamometer and driven at minimum throttle to the vehicle entrance of the enclosure.

(f) The vehicle's engine must be stopped before any part of the vehicle enters the enclosure. The vehicle may be pushed or coasted into the enclosure.

(g) The test vehicle windows and any storage compartments shall be opened, if not already open.

(h) The temperature recording system shall be started and the time of engine shut off shall be

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noted on the evaporative emissions hydrocarbon data recording system.

(i) The enclosure doors shall be closed and sealed within two minutes of engine shutdown and within seven minutes after the end of the exhaust emission test. The steps after the end of the driving cycle should be done as quickly as possible to minimize the time needed to start the hot soak test.

(j) The  $60 \pm 0.5$  minute hot soak begins when the enclosure doors are sealed. The enclosure atmosphere shall be analyzed and recorded. This is the initial (time = 0 minutes) hydrocarbon concentration,  $\text{CHC}_i$ , for use in calculating evaporative losses (see § 86.1243). The “zero” time methanol sample shall be collected starting at the same time as the hydrocarbon analysis is started. Sampling shall continue for four minutes.

(k) The test vehicle shall be permitted to soak for a period of one hour in the enclosure.

(l) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of the test.

(m) Fresh impingers shall be installed in the methanol collection system immediately prior to the end of the test, if applicable.

(n) At the end of the  $60 \pm 0.5$  minute test period, the enclosure atmosphere shall again be analyzed (as described in § 86.1238-90(j) and the time recorded. This is the final (time = 60 minutes) hydrocarbon concentration,  $\text{CHC}_f$  and the final methanol level for use in calculating evaporative losses (see § 86.1243). This operation completes the evaporative emission measurement procedure.

(o) *Alternate method for methanol sampling.* Since sample times of longer than four minutes may be necessary in order to collect an adequate and representative sample of methanol at the end of a test (when SHED concentrations are usually increasing rapidly), it may be necessary to rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flowing through the impingers should be minimized in order to prevent any losses. This alternative must be adopted if the four minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis.

[54 FR 14569, Apr. 11, 1989, as amended at 58 FR 16061, Mar. 24, 1993; 60 FR 43906, Aug. 23, 1995]

### § 86.1238-96 Hot soak test.

(a)(1) *Gasoline- and methanol-fueled vehicles.* For gasoline- and methanol-fueled vehicles, the hot soak test shall be conducted immediately following the running loss test. However, sampling of emissions from the running loss test is not required as preparation for the hot soak test.

(2) *Gaseous-fueled vehicles.* Since gaseous-fueled vehicles are not required to perform a running loss test, the hot soak test shall be conducted within seven minutes after completion of the hot start exhaust test.

(b) The hot soak test may be conducted in the running loss enclosure as a continuation of that test or in a separate enclosure.

(1) If the hot soak test is conducted in the running loss enclosure, the driver may exit the enclosure after the running loss test. If exiting, the driver should use the personnel door described in § 86.1207-96(a)(2), exiting as quickly as possible with a minimum disturbance to the system. The final hydrocarbon and methanol concentration for the running loss test, measured in § 86.1234-96(g)(1)(xx), shall be the initial hydrocarbon and methanol concentration (time=0 minutes)  $\text{CHC}_i$  and  $\text{CCH}_3\text{OH}_i$ , for the hot soak test.

(2) If the vehicle must be moved to a different enclosure, the following steps must be taken:

(i) The enclosure for the hot soak test shall be purged for several minutes prior to completion of the running loss test. WARNING: If at any time the concentration of hydrocarbons, of methanol, or of methanol and hydrocarbons exceeds 15,000 ppm C the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

(ii) The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the test.

(iii) Fresh impingers shall be installed in the methanol sample collection system immediately prior to the start of the test, if applicable.

(iv) If not already on, the mixing fan(s) shall be turned on at this time. Throughout the hot soak test, the mixing fan(s) shall circulate the air at a rate of  $0.8 \pm 0.2$  cfm per cubic foot of the nominal enclosure volume.

(v) Begin sampling as follows:

(A) Analyze the enclosure atmosphere for hydrocarbons and record. This is the initial (time = 0 minutes) hydrocarbon concentration,  $\text{CHC}_i$ , required in § 86.1243. Hydrocarbon emissions may be sampled continuously during the test period.

(B) Analyze the enclosure atmosphere for methanol, if applicable, and record. The methanol sampling must start simultaneously with the initiation of the hydrocarbon analysis and continue for  $4.0 \pm 0.5$  minutes. This is the initial (time=0 minutes) methanol concentration,  $\text{CCH}_3\text{OH}_i$ , required in § 86.1243. Record the time elapsed during this analysis. If the 4-minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of

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the bag sample and flow through the impingers should be minimized to prevent any losses.

(vi) The vehicle engine compartment cover shall be closed (if not already closed), the cooling fan shall be moved, the vehicle shall be disconnected from the dynamometer and any sampling system, and then driven at minimum throttle to the enclosure for the hot soak test. These steps should be done as quickly as possible to minimize the time needed to start the hot soak test.

(vii) The vehicle's engine must be stopped before any part of the vehicle enters the enclosure.

(viii) The vehicle shall enter the enclosure; the enclosure doors shall be closed and sealed within 2 minutes of engine shutdown and within seven minutes after the end of the running loss test.

(ix) The test vehicle windows and any luggage compartments shall be opened (if not already open). The vehicle engine compartment cover shall be closed (if not already closed).

(c) [Reserved]

(d) The temperature recording system shall be started and the time of engine shutoff shall be noted on the evaporative emission hydrocarbon data recording system.

(e) For the first 5 minutes of the hot soak test, the ambient temperature shall be maintained at  $95 \pm 10$  °F. For the remainder of the hot soak test, the ambient temperature shall be maintained at  $95 \pm 5$  °F ( $95 \pm 2$  °F on average).

(f) The  $60 \pm 0.5$  minute hot soak begins when the enclosure doors are sealed (or when the running loss test ends, if the hot soak test is conducted in the running loss enclosure).

(g) The FID (or HFID) hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of the test.

(h) Fresh impingers shall be installed in the methanol collection system immediately prior to the end of the test, if applicable.

(i) [Reserved]

(j) At the end of the  $60 \pm 0.5$  minute test period:

(1) Analyze the enclosure atmosphere for hydrocarbons and record. This is the final (time=60 minutes) hydrocarbon concentration,  $C_{HCF}$ , required in § 86.1243.

(2) Analyze the enclosure atmosphere for methanol and record, if applicable. The methanol sampling must start simultaneously with the initiation of the hydrocarbon analysis and continue for  $4.0 \pm 0.5$  minutes. This is the final (time=60 minutes) methanol concentration,  $C_{CH_3OH}$ , required in § 86.1243. Record the time elapsed during this analysis. If the 4-minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate GC analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of

the bag sample and flow through the impingers should be minimized to prevent any losses.

(k) For the supplemental two-diurnal test sequence (see § 86.1230-96), the hot soak test described in § 86.1238-90 shall be conducted immediately following the dynamometer run. This test requires ambient temperatures between 68° and 86 °F at all times. The equipment and calibration specifications of §§ 86.1207-90 and 86.1207-90 may apply for this testing. Enclosures meeting the requirements of §§ 86.1207-96 and 86.1217-96 may also be used. This hot soak test is followed by two consecutive diurnal heat builds, described in § 86.1233-96(p).

(l) If the vehicle is to be tested for diurnal emissions, follow the procedure outlined in § 86.1233-96.

[58 FR 16061, Mar. 24, 1993, as amended at 59 FR 48524, Sept. 21, 1994; 60 FR 43906, Aug. 23, 1995]

### § 86.1242-90 Records required.

The following information shall be recorded with respect to each test:

(a) Test number.

(b) System or device tested (brief description).

(c) Date and time of day for each part of the test schedule.

(d) Instrument operator.

(e) Driver or operator.

(f) Vehicle: ID number; Manufacturer; Model Year; Engine family; Evaporative emissions family; Basic engine description (including displacement, number of cylinders, and catalyst usage); Engine maximum power rating and rated speed; Fuel system (including number of carburetors, number of carburetor barrels, fuel injection type, fuel tank(s) capacity and location, and number and size (volume and working capacity)) of evaporative control canisters; Engine code; Gross vehicle weight rating; Actual curb weight at zero miles; Actual road load at 50 mph; Transmission configuration; Axle ratio; Vehicle line; Odometer reading; Idle rpm; and Drive wheel tire pressure, as applicable.

(g) Indicated road load power absorption at 50 mph (80 km/hr) and dynamometer serial number. As an alternative to recording the dynamometer serial number, a reference to a vehicle test cell number may be used, provided the test cell records show the pertinent information.

(h) All pertinent instrument information such as tuning, gain, serial number, detector number and range. As an alternative, a reference to a vehicle test cell number may be used, with the advance approval of the Administrator, provided test cell calibration records show the pertinent instrument information.

(i) Recorder charts: Identify zero, span and enclosure gas sample traces.

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(j) Test cell barometric pressure and ambient temperature.

NOTE: A central laboratory barometer may be used: *Provided*, That individual test cell barometric pressures are shown to be within  $\pm 0.1$  percent of the barometric pressure at the central barometer location.

(k) Fuel temperatures as prescribed.

(l) *For methanol-fueled vehicles:* (1) Volume of sample passed through the methanol sampling system and the volume of deionized water in each impinger.

(2) The concentration of the GC analyses of the test samples (methanol).

(m) *For natural gas-fueled vehicles.* Composition, including all carbon containing compounds; e.g. CO<sub>2</sub>, of the natural gas-fuel used during the test. C<sub>1</sub> and C<sub>2</sub> compounds shall be individually reported. C<sub>3</sub> and heavier hydrocarbons, and C<sub>6</sub> and heavier hydrocarbons may be reported as a group.

(n) *For liquefied petroleum gas-fueled vehicles.* Composition of the liquefied petroleum gas-fuel used during the test. Each hydrocarbon compound present, through C<sub>4</sub> compounds, shall be individually reported. C<sub>5</sub> and heavier hydrocarbons may be reported as a group.

[54 FR 14570, Apr. 11, 1989, as amended at 59 FR 48524, Sept. 21, 1994; 60 FR 34363, June 30, 1995]

### § 86.1243-90 Calculations; evaporative emissions.

(a) The calculation of the net hydrocarbon, methanol and hydrocarbon plus methanol mass change in the enclosure is used to determine the diurnal and hot soak mass emissions. The mass changes are calculated from initial and final hydrocarbon and methanol concentrations in ppm carbon, initial and final enclosure ambient temperatures, initial and final barometric pressures, and net enclosure volume using the following equations:

(1) For methanol:

ER06OC93.125

Where:

(i) M<sub>CH<sub>3</sub>OH</sub>=Methanol mass change,  $\mu$ g.

(ii) V<sub>n</sub>=Net enclosure volume, ft<sup>3</sup>, as determined by subtracting 50 ft<sup>3</sup> (1.42 m<sup>3</sup>) (volume of vehicle with trunk and windows open) from the enclosure volume. A manufacturer may use the measured volume of the vehicle (instead of the nominal 50 ft<sup>3</sup>) with advance approval by the Administrator: *Provided*, the measured volume is determined and used for all vehicles tested by that manufacturer.

(iii) T<sub>E</sub>=Temperature of sample withdrawn, °R.

(iv) V<sub>E</sub>=Volume of sample withdrawn, ft<sup>3</sup>.

(v) T<sub>SHED</sub>=Temperature of SHED, °R

(vi) P<sub>B</sub>=Barometric pressure at time of sampling, in. Hg.

(vii) C<sub>MS</sub>=GC concentration of sample.

(viii) AV=Volume of absorbing reagent in impinger.

(ix) i=Initial sample.

(x) f=Final sample.

(xi) 1=First impinger.

(xii) 2=Second impinger.

(2) For hydrocarbons:

ER06OC93.126

Where:

(i) M<sub>HC</sub>=Hydrocarbon mass change, g.

(ii) C<sub>HC</sub>=FID hydrocarbon concentration as ppm carbon including FID response to methanol in the sample.

(iii) C<sub>CH<sub>3</sub>OH</sub>=Methanol concentration as ppm carbon.

ER06OC93.127

(iv) V<sub>n</sub> = Net enclosure volume ft<sup>3</sup> (m<sup>3</sup>), as determined by subtracting 50 ft<sup>3</sup> (1.42 m<sup>3</sup>) (volume of vehicle with trunk and windows open) from the enclosure volume. A manufacturer may use the measured volume of the vehicle (instead of the nominal 50 ft<sup>3</sup>) with advance approval by the Administrator: *Provided*, the measured volume is determined and used for all vehicles tested by that manufacturer.

(v) r = FID response factor to methanol.

(vi) P<sub>B</sub> = Barometric pressure, in Hg (kPa).

(vii) T = Enclosure temperature, °R(°K).

(viii) i = initial reading.

(ix) f = final reading.

(x) 1 = First impinger.

(xi) 2 = Second impinger.

(xii)(A) k = 0.208 (12 + H/C).

(B) *For SI units*, k = 1.2 (12 + H/C).

Where:

(xiii) H/C = hydrogen carbon ratio.

(A) H/C = 2.33 for diurnal emissions.

(B) H/C = 2.2 for hot soak emissions.

(3) For total evaporative emissions:

Total Evaporative Emissions =

ER06OC93.128

(b) The final reported results shall be computed by summing the individual evaporative emission results determined for the diurnal breathing-loss test, running-loss test and the hot-soak test.

[54 FR 14570, Apr. 11, 1989, as amended at 60 FR 34363, June 30, 1995]

### § 86.1243-96 Calculations; evaporative emissions.

(a) The following equations are used to calculate the evaporative emissions from gasoline- and methanol-fueled vehicles, and for gaseous-fueled vehicles.

(b) Use the measurements of initial and final concentrations to determine the mass of hydrocarbons and methanol emitted. For testing with pure gasoline, methanol emissions are assumed to be zero.

(1) For enclosure testing of diurnal, hot soak, and running loss emissions:

(i) Methanol emissions:

ER06OC93.129

Where:

(A)  $M_{CH_2OH}$ =Methanol mass change,  $\mu\text{g}$ .

(B)  $V_{F_n}$ =Net enclosure volume,  $\text{ft}^3$ , as determined by subtracting 50  $\text{ft}^3$  (1.42  $\text{m}^3$ ) (volume of vehicle with trunk and windows open) from the enclosure volume. A manufacturer may use the measured volume of the vehicle (instead of the nominal 50  $\text{ft}^3$ ) with advance approval by the Administrator: Provided, the measured volume is determined and used for all vehicles tested by that manufacturer.

(C) [Reserved]

(D)  $V_E$ =Volume of sample withdrawn,  $\text{ft}^3$ . Sample volumes must be corrected for differences in temperature to be consistent with determination of  $V_n$ , prior to being used in the equation.

(E) [Reserved]

(F)  $AC_{MS}$ =GC concentration of sample.

(G)  $AV$ =Volume of absorbing reagent in impinger.

(H)  $P_B$ =Barometric pressure at time of sampling, in. Hg.

(I) i=Initial sample.

(J) f=Final sample.

(K) 1=First impinger.

(L) 2=Second impinger.

(M)  $M_{CH_3OH,out}$ =mass of methanol exiting the enclosure, in the case of fixed volume enclosures for diurnal emission testing,  $\mu\text{g}$ .

(N)  $M_{CH_3OH,in}$ =mass of methanol entering the enclosure, in the case of fixed volume enclosures for diurnal emission testing,  $\mu\text{g}$ .

(ii) Hydrocarbon emissions:

ER06OC93.130

Where,

(A)  $M_{HC}$ =Hydrocarbon mass change, g.

(B)  $C_{HC}$ =FID hydrocarbon concentration as ppm carbon including FID response to methanol (or methane, as applicable) in the sample.

(C)  $C_{CH_3OH}$ =Methanol concentration as ppm carbon.

ER06OC93.131

(D)  $V_n$ =Net enclosure volume  $\text{ft}^3$  ( $\text{m}^3$ ) as determined by subtracting 50  $\text{ft}^3$  (1.42  $\text{m}^3$ ) (volume of vehicle with trunk and windows open) from the enclosure volume. A manufacturer may use the measured volume of the vehicle (instead of the nominal 50  $\text{ft}^3$ ) with advance approval by the Administrator, provided the measured volume is determined and used for all vehicles tested by that manufacturer.

(E) r=FID response factor to methanol.

(F)  $P_B$ =Barometric pressure, in Hg (Kpa).

(G) T=Enclosure temperature, °R( °K).

(H) i=initial reading.

(I) f=final reading.

(J) 1=First impinger.

(K) 2=Second impinger.

(L) Assuming a hydrogen to carbon ratio of 2.3:

(I)  $k=2.97$ ; and

(2) For SI units,  $k=17.16$ .

(M)  $M_{HC,out}$ =mass of hydrocarbons exiting the enclosure, in the case of fixed-volume enclosures for diurnal emission testing, g.

(N)  $M_{HC,in}$ =mass of hydrocarbons entering the enclosure, in the case of fixed-volume enclosures for diurnal emission testing, g.

(iii) For variable-volume enclosures, defined in § 86.1207(a)(1)(i), the following simplified form of the hydrocarbon mass change equation may be used:

ER06OC93.132

(2) For running loss testing by the point-source method, the mass emissions of each test phase are calculated below, then summed for a total mass emission for the running loss test. If emissions are continuously sampled, the following equations can be used in integral form.

(i) Methanol emissions:

ER06OC93.133

Where,

(A)  $M_{CH_3OH}$ =methanol mass change,  $\mu\text{g}$ .

(B)  $\rho_{CH_3OH}$ = 37.71 g/ $\text{ft}^3$ , density of pure vapor at 68° F.

(C)  $V_{mix}$ =total dilute sample volume, in  $\text{ft}^3$ , calculated as appropriate for the collection technique used.

(D)  $C_{CH_3OH,d}$ =methanol concentration of diluted running loss sample, in ppm carbon equivalent.

(E)  $C_{CH_3OH,d}$ =methanol concentration of dilution air, in ppm carbon equivalent.

(ii) Hydrocarbon emissions:

ER06OC93.134

Where,

(A)  $M_{HC}$ =hydrocarbon mass change, g.

(B)  $\rho_{HC}$ = 16.88 g/ $\text{ft}^3$ , density of pure vapor at 68° F (for hydrogen to carbon ratio of 2.3).

(C)  $V_{mix}$ =total dilute sample volume, in  $\text{ft}^3$ , calculated as appropriate for the collection technique used.

(D)  $C_{HC,d}$ =hydrocarbon concentration of diluted running loss sample, in ppm carbon equivalent.

(E)  $C_{HC,d}$ =hydrocarbon concentration of dilution air, in ppm carbon equivalent.

(c) Calculate the adjusted total mass emissions for each test segment.

ER06OC93.135

where  $M_{DI}$ =mass emissions from the diurnal emission test (see § 86.1233), g.

ER06OC93.136

where  $M_{HS}$ =mass emissions from the hot soak test (see § 86.1238), g.

ER06OC93.137

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where  $M_{RL}$ =mass emissions from the running loss test (see § 86.1234), g.

(d) (1) For the full three-diurnal test sequence, there are two final results to report:

- (i) The sum of the adjusted total mass emissions for the diurnal and hot soak tests ( $M_{DI}+M_{HS}$ ); and
- (ii) The adjusted total mass emissions for the running loss test, on a grams per mile basis= $M_{RL}/D_{RL}$ , where  $D_{RL}$ =miles driven for the running loss test (see § 86.1234-96(c)(6)).

(2) For the supplemental two-diurnal test sequence, there is one final result to report: the sum of the adjusted total mass emissions for the diurnal and hot soak tests ( $M_{DI}+M_{HS}$ ), described in §§ 86.1233-96(p) and 86.1238-96(k), respectively.

[58 FR 16062, Mar. 24, 1993, as amended at 59 FR 48525, Sept. 21, 1994; 60 FR 34364, June 30, 1995; 60 FR 43906, Aug. 23, 1995]

### § 86.1246-96 Fuel dispensing spitback procedure.

(a) The vehicle is fueled at a rate of 10 gal/min to test for fuel spitback emissions. All liquid fuel spitback emissions that occur during the test are collected in a bag made of a material impermeable to hydrocarbons or methanol. The bag shall be designed and used so that liquid fuel does not spit back onto the vehicle body, adjacent floor, etc., and it must not impede the free flow of displaced gasoline vapor from the orifice of the filler pipe. The bag must be designed to permit passage of the dispensing nozzle through the bag. If the bag has been used for previous testing, sufficient time shall be allowed for the bag to dry out. The dispensing nozzle shall be a commercial model, not equipped with vapor recovery hardware.

(b) Ambient temperature levels encountered by the test vehicle shall be not less than 68 °F nor more than 86 °F. The temperatures monitored during testing must be representative of those experienced by the test vehicle. The vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution.

(c) Measure and record the mass of the bag to be used for collecting spitback emissions to the nearest 0.01 gram.

(d) Drain the fuel tank(s) and fill with test fuel, as specified in § 86.1213, to 10 percent of the reported nominal fuel tank capacity. The fuel cap(s) shall be installed immediately after refueling.

(e) The vehicle shall be soaked at  $80\pm6$  °F ( $27\pm3$  °C) for a minimum of six hours, then placed, either by being driven or pushed, on a dynamometer and operated through one Heavy-Duty Vehicle Urban Dynamometer Driving Schedule (specified in § 86.1215 and appendix I of this part). The test vehicle may not be used to set dynamometer horsepower.

(f) Following the preconditioning drive, the vehicle shall be moved or driven at minimum throttle to the refueling area.

(g) All areas in proximity to the vehicle fuel fill orifice and the dispenser nozzle itself shall be completely dry of liquid fuel.

(h) The fuel filler neck shall be snugly fitted with the vented bag to capture any fuel emissions. The fuel nozzle shall be inserted through the bag into the filler neck of the test vehicle to its maximum penetration. The plane of the nozzle's handle shall be perpendicular to the floor of the laboratory.

(i) The fueling procedure consists of dispensing fuel through a nozzle, interrupted by a series of automatic shutoffs. A minimum of 3 seconds shall elapse between any automatic shutoff and subsequent resumption of dispensing. Dispensing may not be manually terminated, unless the test vehicle has already clearly failed the test. The vehicle shall be fueled according to the following procedure:

(1) The fueling operation shall be started within 4 minutes after the vehicle is turned off and within 8 minutes after completion of the preconditioning drive. The average temperature of the dispensed fuel shall be  $65\pm5$  °F ( $18\pm3$  °C).

(2) The fuel shall be dispensed at a rate of  $9.8\pm0.3$  gallons/minute ( $37.1\pm1.1$  l/min) until the automatic shutoff is activated.

(3) If the automatic shutoff is activated before the nozzle has dispensed an amount of fuel equal to 70 percent of the tank's nominal capacity, the dispensing may be resumed at a reduced rate. Repeat as necessary until the nozzle has dispensed an amount of fuel equal to at least 70 percent of the tank's nominal capacity.

(4) Once the automatic shutoff is activated after the nozzle has dispensed an amount of fuel equal to 70 percent of the tank's nominal capacity, the fuel shall be dispensed at a rate of  $5\pm1$  gallons/minute ( $19\pm4$  l/min) for all subsequent dispensing. Dispensing shall be restarted two additional times.

(5) If the nozzle has dispensed an amount of fuel less than 85 percent of the tank's nominal capacity after the two additional dispensing restarts, dispensing shall be resumed, and shall continue through as many automatic shutoffs as necessary to achieve this level. This completes the fueling procedure.

(j) Withdraw the nozzle from the vehicle and the bag, holding the tip of the nozzle upward to avoid any dripping into the bag.

(k) Within 1 minute after completion of the fueling event, the bag shall be folded to minimize the vapor volume inside the bag. The bag shall be folded as quickly as possible to prevent evaporation of collected emissions.

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(l) Within 5 minutes after completion of the fueling event, the mass of the bag and its contents shall be measured and recorded (consistent with paragraph (c) of this section). The bag shall be

weighed as quickly as possible to prevent evaporation of collected emissions.

[58 FR 16063, Mar. 24, 1993, as amended at 60 FR 43906, Aug. 23, 1995]